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ROENTGEN KYMOGRAPHY OF THE RESPIRATORY MOVEMENTS OF THE THORAX, DIAPHRAGM, LUNGS, BRONCHI AND MEDIASTINAL STRUCTURES*†

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IN 1931 the first roentgen kymographic study of the movements of the thorax and integral structures and organs during respiration was reported by Pleikart Stumpf.[28] Stumpf, Professor of Roentgenology at the University of Munich, introduced multiple-slit kymography in 1928,[27] and later developed it into a practical procedure of clinical value. Extensive studies on the movements of the normal and diseased chest have been made by his colleagues, Dahm, Weltz, von der Weth, Cramer, Wilke and Weber. Their work has been incorporated in a new book on roentgen kymography[29] of which Stumpf is the editor. This paper is in part a brief summary and a confirmation of their reports.

A thorough understanding of roentgen kymography is necessary for the interpretation of the films or kymograms. The apparatus is illustrated in Figure 1. The grid is a large sheet of lead in which slits are cut 12 mm. apart. The opening in each slit is 0.4 mm. wide as advocated by Hirsch.[14] During a single, continuous exposure of three to four seconds, the cassette moves slowly down behind the fixed grid a distance slightly less than the grid spacing, actually 11.5 mm. Thus 0.5 mm. of unexposed film remains to divide the kymogram into frames and to prevent an overlapping of exposures. While grids with slits placed 12 mm. apart are suitable for thoracic work, we find that a grid with slits placed 18 mm. apart gives larger and more readable waves.

To record transverse motion the slits in the grid must be placed horizontally and the film moved downward. To record vertical motion the kymograph is rotated

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† We wish to take this opportunity to express our admiration for the American pioneer in the development of roentgen kymography, Dr. A. W. Crane. In his Presidential Address on "Roentgenology of the Heart" before the Seventeenth Annual Meeting of the American Roentgen Ray Society, in 1916, he described his kymograph which was the first to be made in this country.[5] He elucidated the principles and technique of kymography and pointed out its clinical application in the study of heart disease. His contribution was a distinct advance over the work that had previously appeared in Poland and Germany.

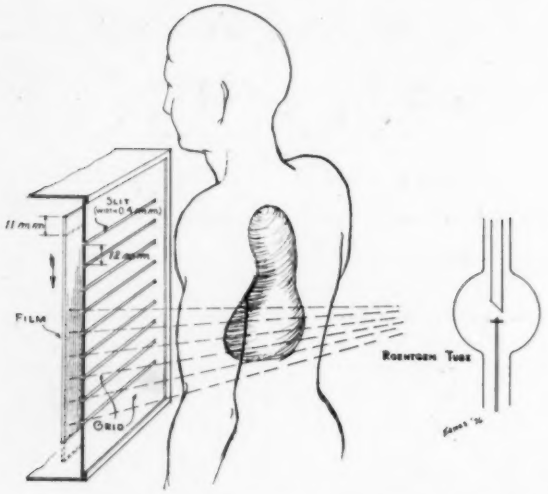


FIG. 1. *Scheme of Roentgen Kymograph (Modified after Stumpf).* Diagrammatic sketch of roentgen kymograph with the lead grid in the horizontal position for recording horizontal motion. Note that the movements of only those areas of the thorax and its contents which overlie a slit will be recorded. Exposure factors for thoracic kymograms of an average adult are: 50 ma., 80 kv. and 3–4 seconds' exposure.

90° so that the slits are vertical and the film is moved crosswise. It should be emphasized that only movement which parallels the slits will be fully registered. Structures without motion or moving at right angles to the slits are recorded as straight, vertical lines (Fig. 2).

The time coördination of the movements of the bony thorax, diaphragm and mediastinal structures can be readily determined by measuring the distance from the white line at the bottom of a frame to the point in question. All points that are equidistant from any white line occurred at the same instant. Another method for determining the time relationship of various movements is outlined in Figure 15.

The thoracic kymogram thus records the simultaneous movements of multiple points that are equally spaced on the border of the ribs, diaphragm, and mediastinal structures inscribed on either 12 or 18 mm. of film. The points recorded are those which overlie a slit in the grid. The procedure may be termed an accurate, objective, and permanent roentgenoscopic observation on a single roentgen film. A more detailed description of the kymograph and the principles of kymography appears elsewhere.[24,25]

RESPIRATORY MOVEMENTS OF THE NORMAL CHEST

Dahm[7] and Weber[29,30,31] have made intensive studies of the movements of the bony thorax and contents during respiration. The anteroposterior kymogram of a normal chest portrays the vertical movement of the posterior portion of the ribs as they increase in amplitude from their

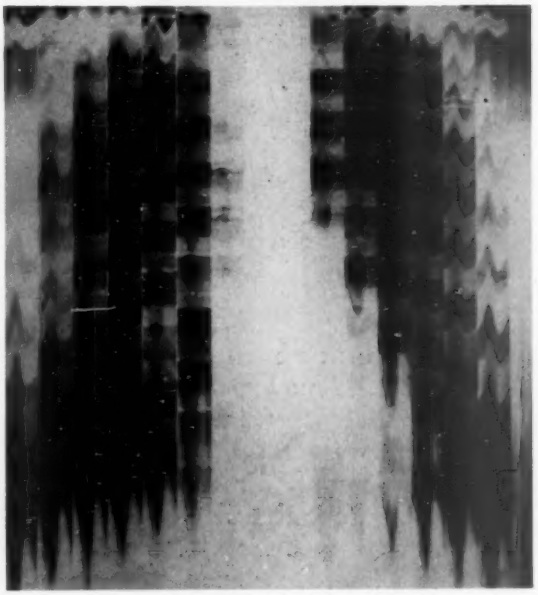


FIG. 2. *Thoracic Roentgen Kymogram of a Normal Chest.* The vertical movements of the posterior segments of the ribs are clearly portrayed as they increase in extent from their spinal attachments to a maximum at the mid axilla. The clavicular motion is greatest at their sternal ends and is synchronous with that of the ribs. The peak (cephalic point of white wave) of the diaphragmatic waves is the position of the diaphragm at full expiration. The troughs of the waves are the same points on the diaphragm at full inspiration. The distance from a white vertical line to the peak of a diaphragmatic wave (high position of diaphragm at expiration) is the same distance as that to a trough on the movement wave of a rib (low position of rib at expiration). This means that the ribs and diaphragm are moving in opposite directions during respiration. These observations are well known facts, but serve to demonstrate the kymographic method.

spinal attachments to the maximum at the mid axilla. The third, fourth, fifth and sixth ribs have the largest excursion. From the seventh rib downward, the movements gradually decrease in extent. The ribs and diaphragm move in opposite directions during respiration. That is, at full expiration the diaphragm is at its highest level which corresponds to the peak of the diaphragmatic waves while the ribs are at their lowest position, as indicated by the trough between the peaks (Fig. 2). The straight right leg of each diaphragmatic wave represents inspiration, and the curved left leg, expiration. The terminal third of expiration is the slowest phase of the respiratory cycle and is thus registered as an oblique line (Fig. 3).

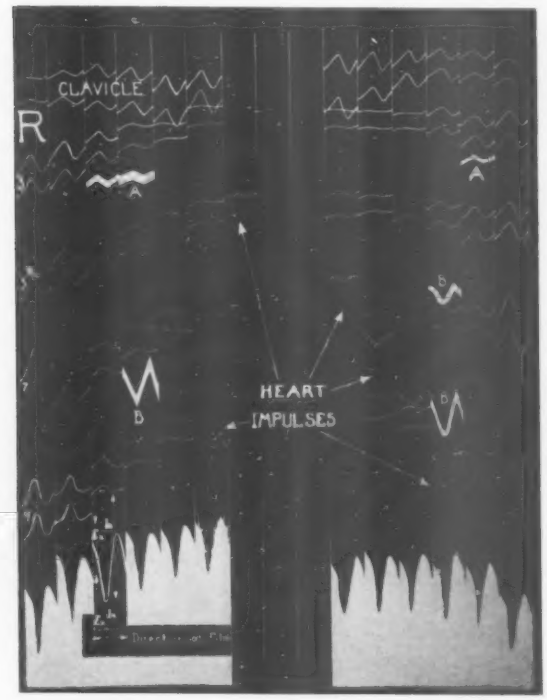


Fig. 3. *Diagrammatic Tracing of Thoracic Kymogram of a Normal Chest.* Diagram has been simplified by omitting every other rib. The straight left leg of the diaphragmatic waves is the inspiratory record and the curved right leg, the expiratory record. The terminal part of expiration is the slowest phase of the respiratory cycle. Our records fail to show any so-called "rest period" during the respiratory cycle. The waves lettered *A* are tracings of upper lobe lung markings and *B* are of the lower lobe markings. Note that these waves move in the opposite direction which indicates that the lung does not expand as one unit. The upper and lower lobes glide past each other in opposite directions at the interlobar fissure as they inflate and deflate. The cardiac movements are recorded as small waves over the heart border (grid in vertical position).

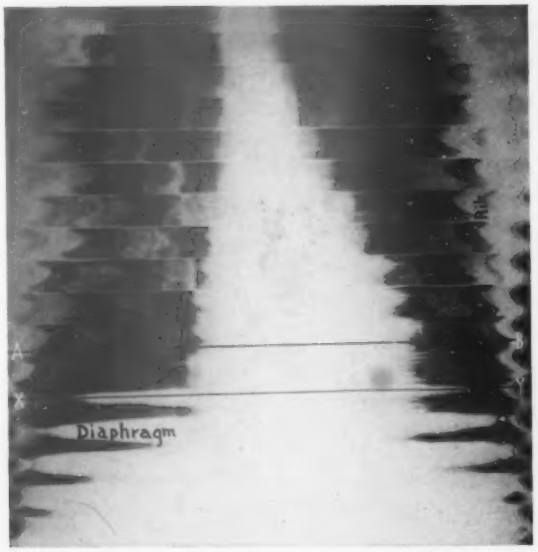


Fig. 4. *Anteroposterior Kymogram for Recording the Lateral Expanding and Medial Contracting Movements of the Thorax.* The largest expansion occurs over the upper portion of the chest. Line *A–B* drawn at moment of maximum inspiration; line *X–Y* drawn at moment of full expiration. The diaphragm is closest to the lateral thoracic wall at expiration (grid in the horizontal position).

Unless otherwise stated, all thoracic kymograms were made during moderately deep respiration.

The anteroposterior kymogram made with the grid placed horizontally records the expansion of the lateral chest wall with inspiration and its contraction with expiration (Fig. 4). The movements are greater over the upper half of the chest. The heart appears widest at expiration and narrowest at inspiration. This change is, however, partly caused by the change in position of the heart as it rises and descends with the diaphragm.

The lateral kymogram with the slits horizontal shows the outward and inward movements of the anterior chest wall which are largest over the upper thorax

FIG. 5. *Lateral Thoracic Kymogram Showing the Outward and Inward Movements of the Anterior Chest Wall.* Note that the heart and trachea, *T*, swing back and forth with the chest wall (grid in the horizontal position).

(Fig. 5). The heart swings forward and backward as it follows the anterior chest wall.

The rise and fall of the anterior chest wall is strikingly pictured in the lateral kymogram made with the grid placed vertically. The greatest excursion takes place in the area of the upper six ribs. In this view the diaphragm becomes an interesting "movement picture" of its anatomical architecture. The long posterior leaf of the diaphragmatic muscle has a large excursion while in the region of the central tendon and the stubby anterior leaf the excursions are very small. The movements of the dorsal spine are recorded and it is seen to straighten[7] with forced inspiration. Wenckebach[32] termed this motion the "respiratory function of the vertebrae."

Weber[29,30,31] and his colleagues[4,21] recognized that the movements of the chest could be separated into the two groups of thoracic motion described by Sir Arthur Keith[19,20] in his classical treatise on the mechanics of respiration:

1. A costovertebral mechanism formed by the second, third, fourth and fifth ribs, the function of which is the expansion of the upper lobe of the lung (the part above the great fissure) by elevating and enlarging the thorax.

2. A costodiaphragmatic mechanism formed by the sixth, seventh, eighth, ninth and tenth ribs which, with the diaphragm, act as a unit for the expansion of the lower lobe, the diaphragm being the dominant factor.

Anatomical[1,19,20] and kymographic studies establish the sixth rib as the borderline between the two mechanisms. The level of the sixth rib coincides with the position of the interlobar fissure which we

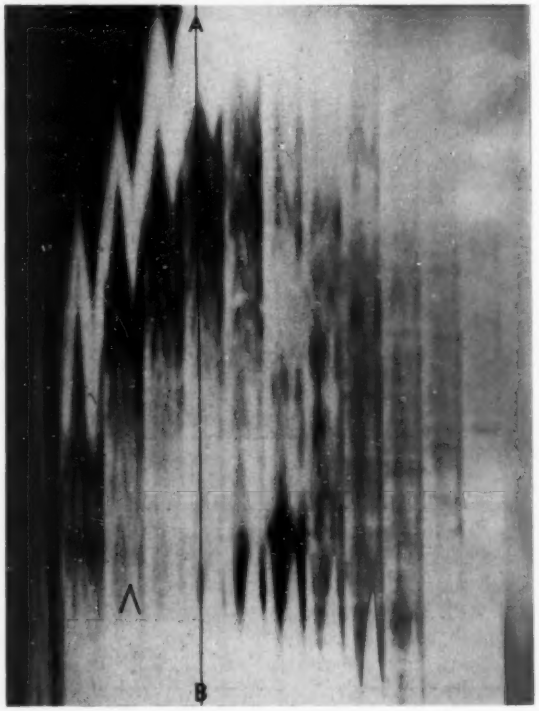


FIG. 6. *Lateral Kymogram of Thorax for Recording the Vertical Shift of the Anterior Chest Wall.* The largest and most effective diaphragmatic excursion is over the posterior leaf and the least over the anterior leaf. Line *A–B* drawn at a period of maximum inspiration. The diaphragm is at its lowest position and the anterior chest wall at its highest (grid in vertical position).

will see assumes a definite function in the expansion of the lung (Fig. 7).

The lungs do not move as single units, but as individual lobes. The upper lobe and, for the most part, the middle lobe expand upward, forward and outward and always remain in contact with the same portion of the thorax during respiration. The lower lobes expand chiefly by following the downward descent of the diaphragm as they glide past the thoracic wall. During respiration the lobes of the lung glide past each other in opposite directions at the interlobar fissures (Fig. 3).

From these studies it is clear why phrenicectomy is most effective in lesions of the lower lobe. Kremer and von der Weth[21] developed a group of kymographic signs which they and others[19,24,29] have successfully used for determining the indications for phrenicectomy in upper lobe lesions.

It should be emphasized that these studies have all been made during deep respiration, and that all the movements are considerably decreased in extent during ordinary quiet respiration.

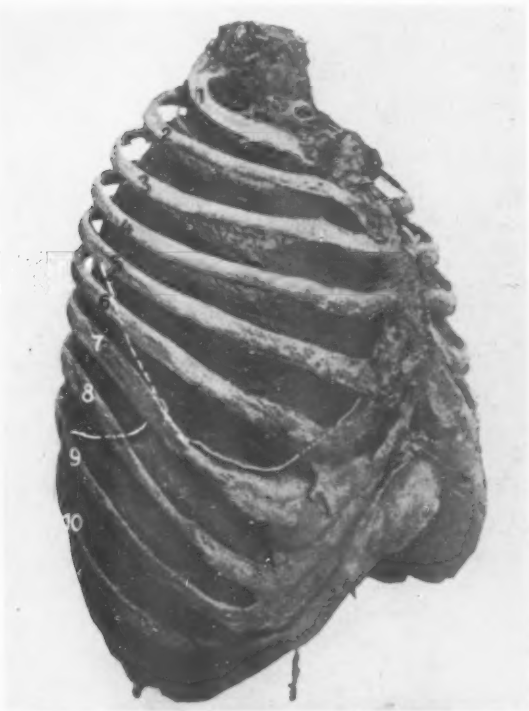


Fig. 7. A dissection of the thorax which illustrates how closely the sixth rib parallels the position of the interlobar fissure (after Aschoff).

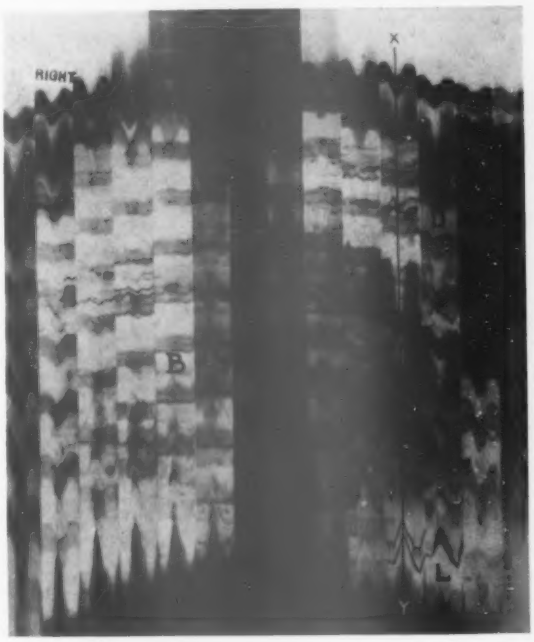


Fig. 8. *Anteroposterior Kymogram of the Tracheobronchial Tree Made after Lipiodol Injection and during Deep Respiration.* The grid was placed in the vertical position for recording the vertical excursion of the trachea, main and secondary bronchial divisions. The vertical shift between full inspiration and expiration in this instance, allowing for distortion, measures about 0.8 cm. for trachea, 0.9 cm. main stem bronchi, and 1.6 cm. for secondary and terminal divisions of the lower lobes. Line *X–Y* drawn at moment of full expiration; *U*, movements of upper lobe bronchi; *L*, movements of lower lobe bronchi; *B*, movement of right main bronchus. Irregular movements of left leaf of diaphragm caused by adhesions.

THE MOVEMENTS OF THE TRACHEOBRONCHIAL TREE DURING RESPIRATION*

The movements of the tracheobronchial tree during respiration have been admirably investigated by Jackson,[16,17] Heinbecker,[12,13] Ballon and Ballon,[2] Francis,[10] Macklin,[22,23] and particularly by Hudson and Jarre[15] and Jarre[18] with their ingenious

* Studies on the tracheobronchial tree were made with Dr. J. J. Singer and Dr. Paul Kunkel, of the Medical and Surgical Chest Service of Washington University School of Medicine. They will be published in detail elsewhere.

FIG. 9. *Anteroposterior Bronchial Kymogram Made with the Grid in Horizontal Position.* The lateral outward and medial inward excursions of the bronchi are recorded. They are synchronous with the lateral thoracic walls and of approximately the same extent at the periphery of the lung. Note movements of trachea and irregular movements of right leaf of diaphragm. *H*, cardiac border; *D*, diaphragm; *R*, lateral of bony thorax. Time record inscribed in upper right corner of film. Each wave is one-fifth of a second. Total exposure time three seconds.

cinex-camera. These studies uniformly agree that the fundamental bronchial movement is one of lengthening during inspiration and of shortening during expiration. Simultaneously with the lengthening, the bronchial lumen enlarges and with the shortening, the lumen narrows. The stretching and contracting movement of the bronchi, when studied kymographically, are divided into a vertical component and a horizontal component. This was first demonstrated by Cramer, Wilke and Weber[4] and Weber.[29]

The anteroposterior kymogram with the grid placed vertically records the vertical component of the bronchial movements (Fig. 8). The bronchial kymograms were made after injection of lipiodol and during forced respiration. The vertical excursions of the lower lobe bronchi are largest, are synchronous with the diaphragm, and are approximately of the same extent in the inferior portion of the lobe. The upper lobe bronchi move less, and the movements are synchronous with those of the ribs. The trachea and main bronchi exhibit a similar vertical shift that is synchronous with the diaphragm, indicating that the lung roots move downward with inspiration and upward with expiration.

When the grid is turned to the horizontal position, the lateral component of the bronchial movements is registered (Fig. 9). Here again the greater bronchial excursion occurs in the lower lobe and less in the upper. In both lobes the lateral bronchial motion is synchronous with the lateral thoracic walls which move outward on inspiration and medially on expiration. This to and fro bronchial movement has been compared to the opening and closing of a fan.[15] On inspiration most of the lower lobe bronchi follow the laterally expanding

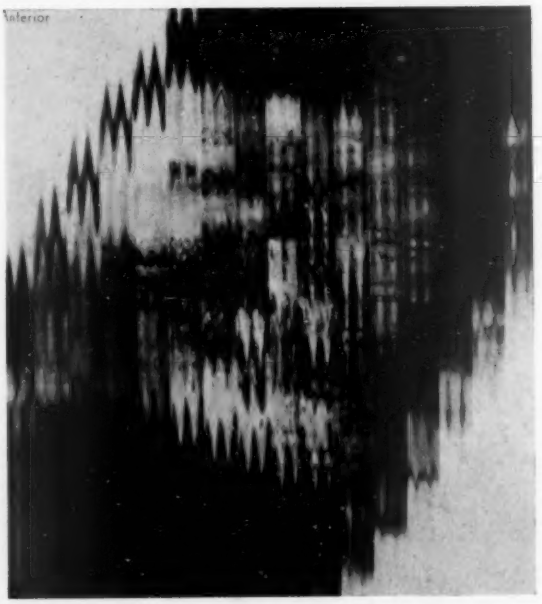


FIG. 10. *Lateral Bronchial Kymogram with Grid Vertical.* The vertical excursions of the bronchi are recorded. The movements of the upper lobe bronchi are synchronous with the sternum and ribs while other bronchi follow the diaphragmatic movement. The movements of the dorsal vertebrae are also recorded, and are of various time occurrences.

ribs, but a few of the medial divisions move in the opposite direction toward the heart. This medial movement of a few lower lobe bronchi was first recognized by Hudson and Jarre.[15]

In the lateral kymogram with the grids horizontal, the trachea, bronchi and heart all shift anteriorly with inspiration to follow the outward moving chest wall. With the grid in the vertical position the bronchial excursions are largest in the region of the posterior diaphragmatic leaf (Fig. 10).

The transmitted motion produced by the pulsations of the heart and pulmonary arteries constitutes a second type of bronchial motion (Fig. 11). Bronchi adjacent to these structures may be displaced 4.0 to 8.0 mm. by this force alone. Figure 11 was made after a lipiodol injection with the patient holding his breath. The recorded movement waves are all pulsatory in origin. Other kymograms show that these movements occur in many planes, and emphasize the necessity of short time exposures for chest films to obliterate blurring due to motion.

Macklin[22] makes the interesting observation that the branches of the pulmonary artery and vein lengthen synchronously with the bronchial tree, to the same extent, to the same degree, and by the same mechanism. Like the bronchi they do not narrow during the lengthening process.

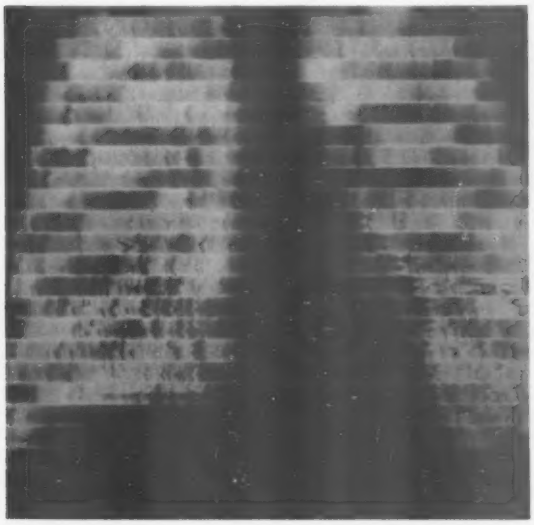


Fig. 11. *Bronchial Movements Produced by the Transmitted Pulsations of the Heart.* The bronchial excursions are greatest near the heart and least at the periphery of the lung. Film made with patient holding his breath (grid in the horizontal position).

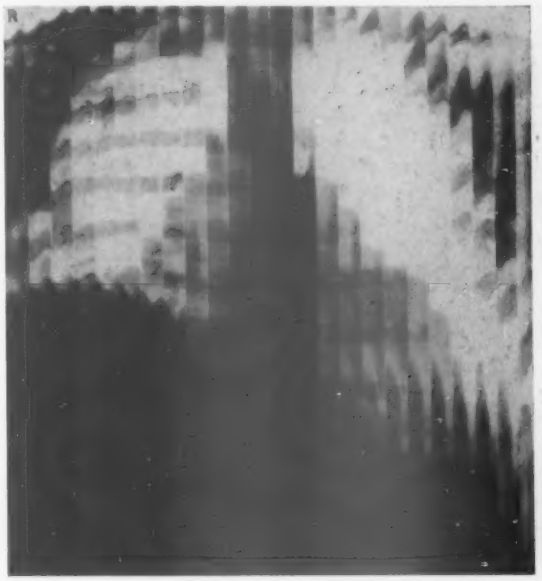


Fig. 12. *Limitation of Motion Exhibited by Elevated Leaf of Diaphragm.* In our experience an elevation of one side of the diaphragm from any cause results in a limited excursion of the affected side. Note that both leaves of the diaphragm move synchronously. Compare with Figure 14 (anteroposterior kymogram with grid horizontal).

MOVEMENTS OF THE DIAPHRAGM

Cunningham[6] writes that "The diaphragm, after the heart, is the most important muscle in the body . . . and is the chief muscle of respiration." Its movements are of clinical importance and are recorded in detail by the kymographic method.

A study[26] of over 30 thoracic kymograms in which one side of the diaphragm was elevated revealed without exception a decrease in the excursion of the affected side. Cases of lobar pneumonia, lung abcesses, lung cysts, lung tumors, bronchiectasis, atelectasis, phrenicectomy, tuberculosis, and intra-abdominal lesions were included. Figure 12 is typical of the group. The right leaf of the diaphragm is elevated. Its ex-

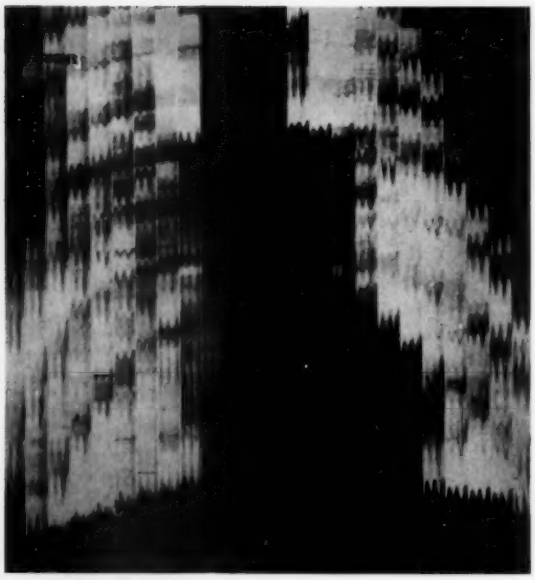


FIG. 13. *Emphysema of the Obstructive Type.* The diaphragmatic excursions are greatly reduced. Terminal phase of expiration is represented by a vertical line indicating a rapid movement. The waves over the outer half of the right diaphragm are irregular, uncoördinated, and bizarre due to diaphragmatic and pleural adhesions.

cursions are feeble but of the same time occurrence as its normally moving fellow.

The location and extent of diaphragmatic adhesions are pictured as irregular areas without motion or as irregular, notched waves of a different time occurrence from those in the remaining portions of the diaphragm. The movements over the medial portion of the right leaf of the diaphragm are adequate, while those in the area of the adhesions are bizarre and the waves are irregular (Fig. 13).

Dahm[8,29] reports that in the presence of peritoneal irritation produced by acute cholangitis, subphrenic abscess, and perinephritic abscess, the diaphragmatic movements are decreased, as in deep breathing the movement of the abdominal wall is painful. Abdominal ascites permits only limited diaphragmatic motion due to the increased intra-abdominal pressure. The same is true in pneumoperitoneum and advanced pregnancy.

In senile emphysema of the obstructive type, the diaphragm is flattened, occupies a low position and possesses a very limited excursion. The terminal phase of expiration is faster than the beginning which is the reverse of that which occurs in normal lungs. We attribute this to a forceful, voluntary contraction of the muscles of expiration in a final effort to expel the air (Fig. 13).

After phrenicectomy or phrenico-exeresis there develops a true paradoxical movement of the diaphragmatic leaves. On the normal right side, the peak of the diaphragmatic wave is at expiration while on the operated side, the diaphragm is at the inspiratory position as shown by the trough (Fig. 14). The movements of the markings in the left lower lobe are also paradoxical.

We have observed 5 patients in whom the phrenic nerve was crushed. In each

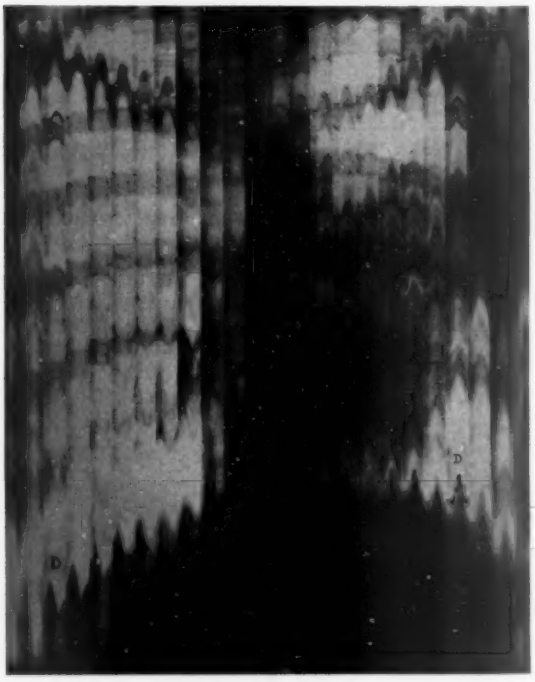


FIG. 14. *True Paradoxical Movement of the Diaphragm.* The left leaf is elevated, exhibits some limitation of motion, and is synchronous with that of the ribs. The right side of the diaphragm moves normally—in the opposite direction to the ribs. The distance from a black vertical line to a peak (cephalic point—expiratory position) on the left diaphragm corresponds to a trough on the movement record of the right diaphragm (anteroposterior thoracic kymogram with vertical grid).

instance the movement of the involved side was lessened and lagged slightly behind that of the normal leaf. It is not a true paradoxical movement, but simply a delay. The term, "pseudoparadoxical movement," has been applied to this type of motion by Dahm[8] (Fig. 5).

MEDIASTINAL MOVEMENTS

A side to side shift of the mediastinum and its contents (heart, trachea, lung roots, etc.) during respiration is an important diagnostic sign in the detection of bronchial foreign bodies[26] and obstructions. At times roentgenoscopic observations are uncertain, as are even roentgenograms made at inspiration and expiration. Kymography is excellently adapted to this type of work as it records the movements of the mediastinal contents, ribs and diaphragm throughout the respiratory cycle, and permits an accurate time analysis of these related movements.

In normal lungs the pressure in both pleural cavities is equal and a shift in the mediastinum does not occur. In pneumothorax the intrapleural pressures are unequal, and there results a marked to and fro shift of the heart with respiration (Fig. 15). On inspiration these structures are pushed to the side of the pneumothorax by the expansion of the normal lung and return to their original position on expiration.

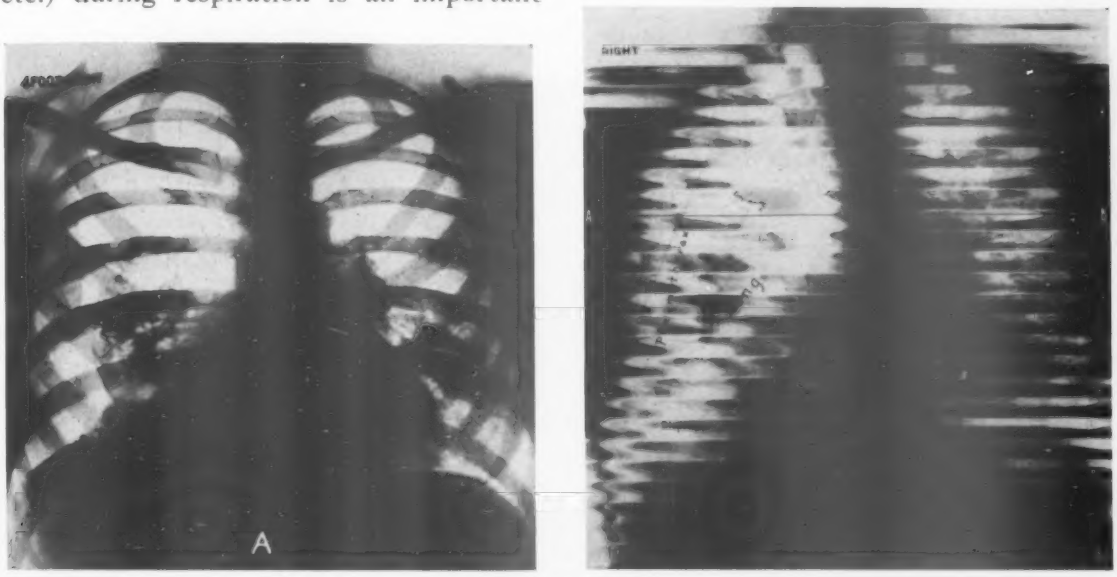


Fig. 15. *Shift of Mediastinal Structures Produced by a Pneumothorax. A.* Roentgenogram showing artificial pneumothorax on right side. *B.* Anteroposterior kymogram made with grid in horizontal position. At full inspiration, line *A–B*, the ribs are at the farthest lateral point of their waves. The record of the heart shows it to be farthest to the right at this phase of the respiratory cycle. The small waves over the border of the collapsed lung are the record of transmitted cardiac pulsations. A simple method for determining the time occurrence of movements of various structures is to draw a line parallel to the base line of a frame through a known point on the movement wave of a structure. In this case the most lateral peak on the movement wave of a rib is the position of that rib at full inspiration. The parallel line *A–B* is drawn through this point. All points on the movement waves of other structures crossed by the line *A–B* were recorded simultaneously and necessarily occurred at the same instant.

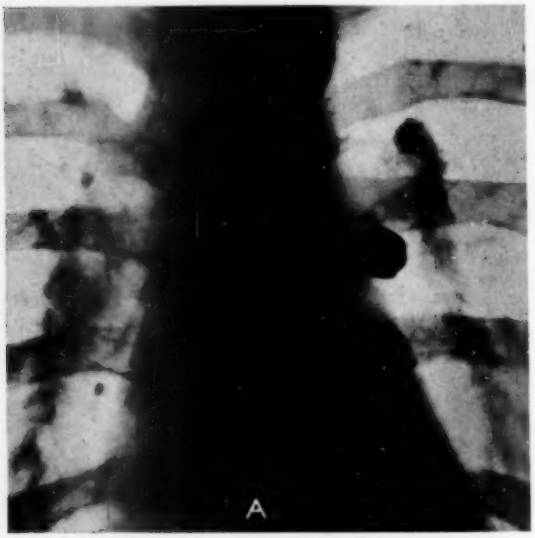
The mediastinal excursion varies from 1 to 2 cm. on forced respiration. Excursions of this size emphasize the risk of continuing a pneumothorax when a small band of adhesions extends between the lung and the chest wall.

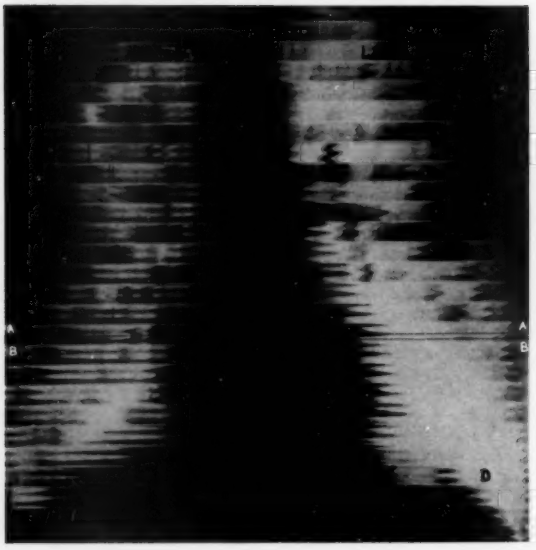
The roentgenological detection of non-opaque foreign bodies in a main bronchus depends largely on the establishment of an obstructive emphysema on the side of the foreign body and the consequent medi-

astinal swing with respiration. In Figure 16*A* a gold dental crown is present in the left main bronchus. The kymogram was made during forced respiration and graphically portrays the obstructive emphysema on the left (Fig. 16*B*). At inspiration the ribs are in their lateral position and the heart is in the midline. With expiration the ribs move medially, while the heart is shifted to the right by the left lung, which remains inflated. The ribs and diaphragm on the left side move less than those on the right.

After the bronchoscopic removal of the crown, the heart and mediastinal contents no longer shifted laterally. The rib and diaphragmatic movements are equal on the two sides (Fig. 16*C*).

A different type of mediastinal shift occurs during respiration when a bronchus is partially obstructed. The obstructive lesion may be intrabronchial, such as a bronchogenic carcinoma,[9,29] or extrabronchial, such as an aneurysm (Fig. 17*A*). With quick inspiration air is promptly drawn through the normal bronchus, but passes slowly through the narrowed bronchus (Fig. 17*B*). The normal lung is quickly inflated. The lung on the obstructed side inflates slowly which increases the negative pleural pressure. This in turn draws the mediastinal contents toward the obstructed side. At expiration the reverse occurs.





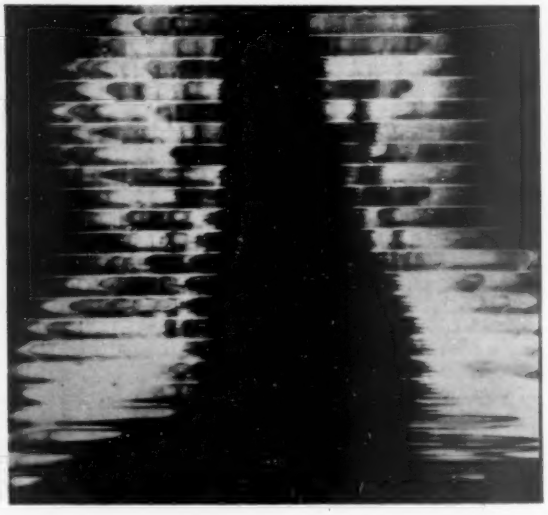


FIG. 16. *Mediastinal Shift Caused by Foreign Body in Left Main Bronchus. A.* Roentgenogram of gold crown in left main bronchus. *B.* Line *A–A* is drawn through the point representing full inspiration on the movement wave of a rib. Where the parallel line crosses the cardiac border, the heart is at its farthest position to the left. Line *B–B* is drawn through the point on the rib wave represented by full expiration. Now the same borders of the heart have been shifted to the right (normal side) (anteroposterior kymogram with grid horizontal). Note decreased movement of the ribs and diaphragm on the left side as compared to that on the right. *C.* Kymogram of same patient made shortly after bronchoscopic removal of the crown. The heart does not shift sidewise. The movements of the ribs and diaphragm are equal on the two sides.

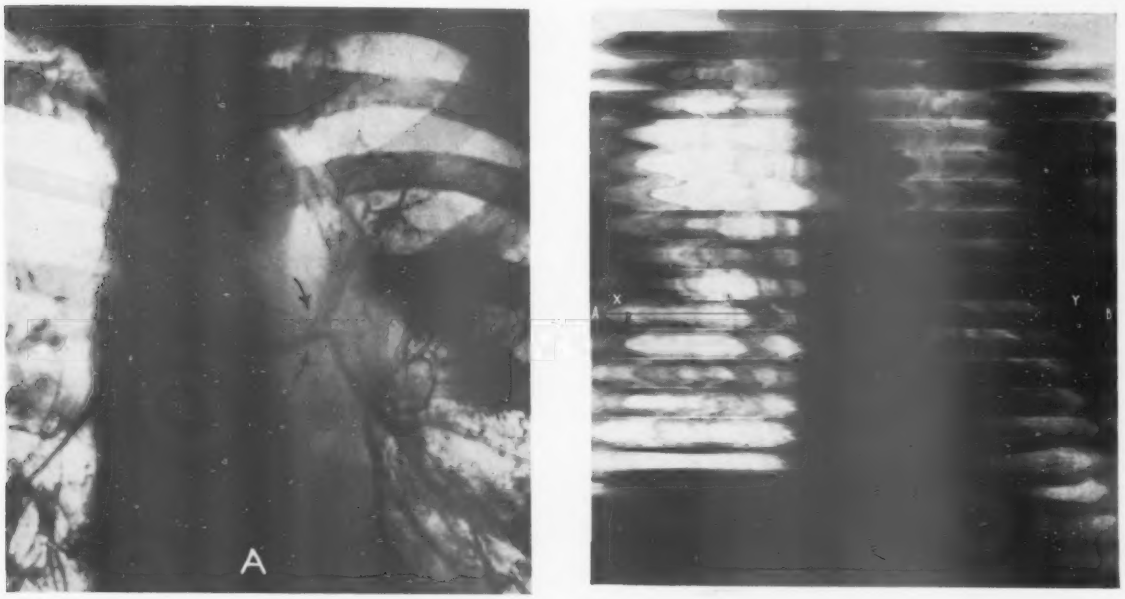


Fig. 17. *Mediastinal Shift Produced by Partial Occlusion of Left Main Bronchus. A.* Bronchogram showing partial occlusion of left main bronchus resulting from pressure of an adjacent aortic aneurysm. *B.* On the line *A–B* drawn at period of full inspiration the borders of the heart and trachea are farthest to the left, the side of the lesion which is just the opposite to that produced by bronchial foreign bodies (Fig. 16*B*). At full expiration (line *X–Y*) these borders have shifted to the right (anteroposterior kymogram with grid horizontal).

The close relationship between mediastinal diaphragmatic movements is pertinent to this discussion and it is aptly stated by Dahm that "mediastinal wandering" is a very important sign of pathological diaphragmatic movements. Likewise disordered diaphragmatic motion is a frequent accompaniment of mediastinal shifting, and the detection of one should incite the investigation of the other.

CONCLUSIONS

1. Roentgen kymography is a practical and valuable method of graphically portraying the physiological movements of the thoracic cage and its contents.

2. It affords a permanent record of the movements of the ribs, diaphragm and mediastinal structures. The amplitude, speed, direction and time occurrence of these movements can be analyzed at leisure.

3. Thoracic roentgen kymography appears to be a promising clinical method for the diagnosis of various diseases of the chest and related structures. The attainment of this may be possible after considerable work by many investigators in the establishment of precedents and the development of the technique.

4. At present, thoracic kymography is an excellent addition to the armamentarium for the investigation of physiological movements in the field of research.*

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Vol. 37, No. 6

INFLAMMATORY DIVERTICULA OF THE PERICARDIUM*

(ENCAPSULATED PERICARDIAL EFFUSION)

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THE localized encapsulation of pericardial fluid was considered a rare condition until Kienböck and Weiss,[4] in 1929, described its roentgenological manifestations. They studied 3 cases, the last of which came to autopsy, and helped to explain the roentgenological findings in the 2 previously seen cases. Kienböck's first case was observed during a period of ten years and was demonstrated at several meetings of the Vienna Medical Society under intermittently changed diagnosis of mediastinal tumor and aneurysm of the root of the aorta.

Anatomically the disease is a combination of pericardial scar tissue formation, with more or less marked adhesions and with exudate formation in a localized part of the pericardium which has not been previously obliterated. Through the continued, slow exudation, the remaining portion of the pericardial cavity stretches. This stretching leads to diverticulum formation. The diverticulum is either a false one, the serous layer bulging through a defect of the fibrous capsule or a true one involving all the pericardial layers just like a pulsion diverticulum of the esophagus involves every layer of that organ; hence the name, "inflammatory pulsion diverticulum of the pericardium." Microscopic studies of the wall of the diverticulum in several cases which have come to autopsy (Schroetter[6]) showed them to consist of only an endothelial layer, the fibrous layer being absent at the site of herniation.

The encapsulated fluid is usually a turbulent, serohemorrhagic one, hence the name of chronic cystic hemorrhagic exudative pericarditis or inflammatory diverticulum of the pericardium. The conditions which lead to the formation of pericardial scar tissue may also lead to the formation of pericardial inflammatory diverticula. The condition is not to be identified with the congenital diverticula of the pericardium which show no evidence of previous or present inflammatory changes, and contain clear, watery fluid. Diverticula of the congenital type were reported by Lauer[5] and by Yater.[7]

Roentgenologically the heart is either enlarged or of normal size, with the exception of the region of the effusion, which is represented by a sharply defined or lobulated semicircular area of bulging or by a hexagonal protrusion. This protrusion is connected with the lateral contour of the heart, either by a broad base, or by a narrow stem, depending on the size of the opening into the diverticulum. The diverticulum may occur in any part of the heart, but the site of predilection is the lower right contour, near the anterior surface. Occasionally, in the erect position, its lower border is separated from the heart by upward indentation as though the weight of the mass would sink downward by its gravity. The mass may follow the respiratory excursions of the heart or may remain stationary together with the heart. It may, or may not, pulsate, depending on the thickness of the scar. Kienböck's 3 cases all showed, in addition to the bulging on the right side, a generalized cardiac enlargement. In the cases reported by Ernst[2] and by Jansson[3] only the right side of the heart shadow showed a bulging. The configuration and the size of the left cardiac silhouette were normal. Of our 2 cases 1 showed a generalized

* Read at the Thirty-seventh Annual Meeting, American Roentgen Ray Society, Cleveland, Ohio, Sept. 29–Oct. 2, 1936.

cardiac enlargement while the second showed no cardiac enlargement except in the region of the diverticulum.

Jansson called attention to the respiratory changes in the diverticulum as an additional differential diagnostic sign, caused by an inspiratory stretching and expiratory relaxation of the mediastinal pleura which is situated laterally to the

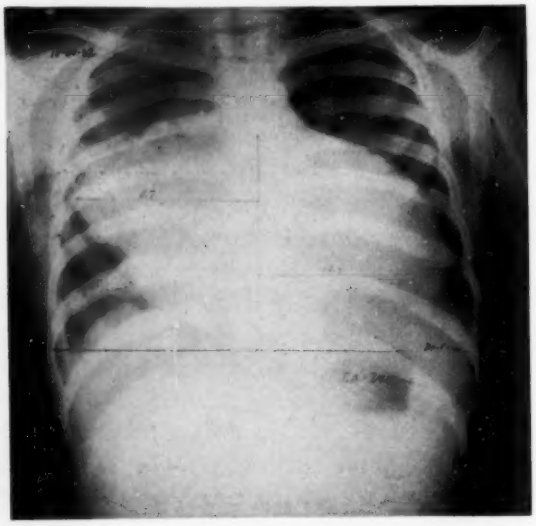

FIG. 1. Case 1. The heart shadow is markedly enlarged and globular. Overlapping the upper right cardiac contour there is a semicircular outward convex shadow.

diverticulum. In his case the diverticulum flattened out in inspiration and became broader in expiration.

From a differential diagnostic standpoint, cardiac aneurysms, aneurysm of the root of the aorta, mediastinal or lung tumors have to be considered. Cardiac aneurysms may resemble in size and configuration the pericardial diverticulum, but are usually on the left side. Mediastinal tumors are most commonly situated in the upper mediastinum and not near the diaphragm as is this lesion. Aortic aneurysms are probably the most difficult to differentiate from pericardial diverticula. The normal size of the remaining aorta, the indentations of the basal part of the protuberance, and the clinical symptomatology will usually allow the exclusion of aneurysm. Lung tumors are very rarely as sharply defined as pericardial diverticula. Examination after injection of lipiodol into the main bronchus may clarify some of the difficult cases.

This report is upon 2 cases of encapsulated pericardial effusions. The first case showed great similarity with those which have been recently reported as pericardial diverticula. Yet, the biposy of the pericardial sac showed no evidence of herniation as the capsule consisted of fibrous tissue instead of serous layer, indicating that in contradistinction to Kienböck and Weiss' case, this one was a true pericardial diverticulum.

We were also able to demonstrate in this case an inspiratory flattening and expiratory broadening of the encapsulated fluid, as described by Jansson. The second case had an unusual feature in that the encapsulated pericardial effusion was in communication with a bulging subcutaneous structure on the anterior thoracic wall. Whether this structure represented a herniated part of the pericardium cannot be determined because no biposy was taken.

CASE REPORTS

CASE 1. L. W., male, aged fourteen, was admitted with the complaint of fever and pain in the right shoulder and upper chest of two years' duration. Two years before admission the patient developed a pericardial effusion and his pericardial cavity was tapped five times. On admission, his temperature varied between 38.0°–39.0° C. The blood pressure was 110/70 and the venous pressure 12.5 cm. of water.

Roentgen studies made elsewhere on October 20, 1932, showed a marked globular enlargement of the heart shadow to the left as well as to the right. Its transverse diameter measured 24.1 cm. at its widest, with the transverse diameter of the chest measuring 26.8 cm. The upper mediastinum was enlarged to the right. Overlapping the upper half of the right cardiac contour there was a semicircular shadow of increased density, which measured about 8 cm. in diameter and extended almost to the lateral chest wall (Fig. 1). The diagnosis was made of effusion into the pericardial cavity with encapsulation on the right side.

Roentgen examination on June 2, 1934, showed that the left half of the heart had decreased considerably in size during the interval. The left cardiac contour was almost normal. There was a marked double-oval shaped protrusion along the entire right cardiac border by a sharp depression. The protruding area measured 14 cm. in length, 8 cm. in width at its lowest point and 4 cm. in width at its upper portion (Figs. 2 and 3). The shadow of the superior vena cava appeared to be enlarged. The structure on the right showed no pulsations, while the pulsations on the left were normal. On inspiration the shadow stretched and became narrower and longer, while in expiration it became wider and shorter.

Pericardiotomy was performed on June 26, 1934, by Dr. C. S. Beck. The right half of the pericardium was exposed and incised. It was found to be very thick, measuring 5–6 mm. and the cavity contained about 300 c.c. of thick, yellow pus. The pus-containing sac was walled off from the general pericardial cavity and the adhesions were broken. Examination of the pus showed small Much's granules, probably representing involutional forms of tubercle bacilli. The biopsy of the pericardial scar showed a mass of dense, fibrous connective tissue which was infiltrated by some polymorphonuclear leukocytes and a large number of lymphocytes.

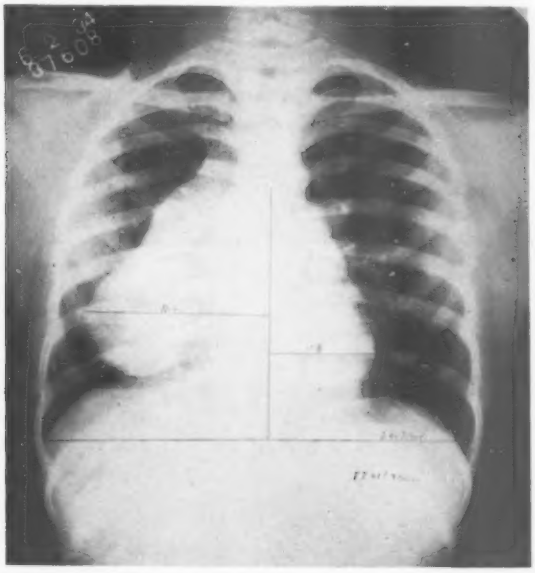

FIG. 2. Case I. Examination about nineteen and a half months later shows the left cardiac contour to be normal. There is a remaining double-oval protrusion along the entire right cardiac contour, due to encapsulated pericardial effusion.

FIG. 3. Case I. Second oblique view showing the protruding shadows to be situated on the anterolateral surface of the right heart.

A check examination two years later showed the size of the encapsulated pericardial fluid to have decreased but slightly. The lower border of the structure showed at this time areas of pericardial calcification. The patient's general condition improved after the operation and there was no longer elevation of temperature. The venous pressure equalled 4 cm. of water.

CASE II. This patient, a male, aged forty-eight, was admitted because of a fluctuating mass to the right of the sternum of five years' duration, associated with a sensation of oppression in the substernal region, shortness of breath on exertion, palpitation and occasional dizziness.*

Examination revealed the cervical veins to be engorged. There was a soft, fluctuating, nontender, rounded protuberance a little to the right of the sternum (Fig. 4), which pulsated synchronously with the heart and could be partially reduced. It measured about 8 cm. in diameter. The heart sounds were of fair quality, but there was a systolic murmur at the apex. On aspiration, 180 c.c. of orange-red fluid was

* The clinical features of this case have been reported by Cushing.[1]

FIG. 4. Case II. Photograph showing protruding mass a little to the right of the midportion of the sternum.

removed, a smear of which contained tubercle bacilli.

Roentgen examination on December 4, 1935, revealed a markedly enlarged heart shadow. The enlargement was due to an ovoid structure, which measured 14 cm. in length and 6 cm. in width (Fig. 5). It had a sharply defined outer contour which contained linear areas of calcification. In the lateral view it appeared to be situated just posterior to the sternum. The left border of the heart was slightly enlarged and the cardiac incisura was filled out. There was also some calcification throughout the left and posterior borders of the heart. The heart appeared to be adherent to the sternum. During respiration the right border of the heart remained unchanged, while the left border changed slightly. There were no pulsations throughout the right border of the heart. The left cardiac contour showed vigorous pulsations. The absence of pulsations on the right was well demonstrated on the kymogram taken a year later.

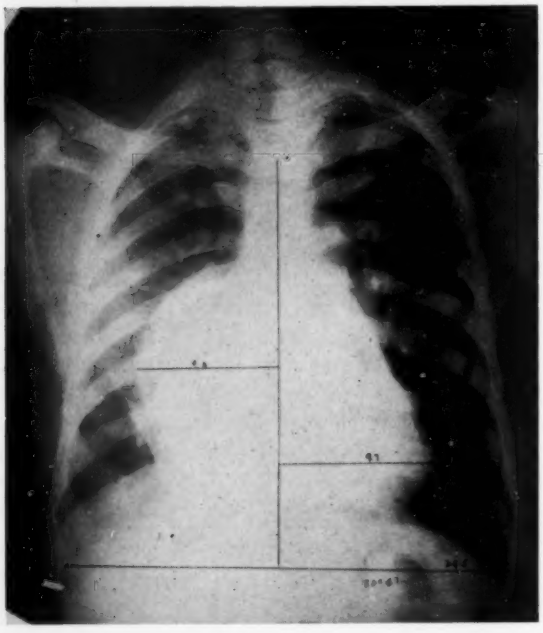

FIG. 5. Case II. Anteroposterior view showing the left cardiac contour to be normal. There is an ovoid structure overlapping the right cardiac contour, which measures 14 cm. in length and 6 cm. in width.

FIG. 6. Case II. Lateral view of the chest taken after aspiration of fluid and injection of air into the protruding mass of the anterior chest wall. The mass is in communication with the pericardial cavity as indicated by the presence of air in the pericardium.

On December 5, 1935, after the aspiration of fluid, air was injected into the protruding mass on the right anterior chest wall. Roentgenograms taken subsequently showed air in the protruding mass, as well as in the pericardial cavity, indicating that the structure on the anterior chest wall communicated with the pericardium (Fig. 6).

Autopsy performed on January 22, 1937, showed an abscess cavity in the pericardium which measured 15 cm. in diameter and was lined with shaggy, yellow and gray, soft, necrotic tissue and the base of which was formed by the epicardium. It contained 350 c.c. of cloudy, yellowish brown fluid. The pericardium surrounding the abscess cavity and that covering the posterior and lateral portions of the heart was entirely calcified, being in some places 5 mm. thick. It was firmly adherent to the epicardium. The anteroposterior diameter of the right auricle was markedly shortened due to the pressure of the encroaching abscess cavity. A sinus tract extended through an eroded rib cartilage from the pericardial abscess into a thick-walled cyst-like structure measuring approximately 3 cm. in diameter, embedded in the right pectoral muscle. The cavity contained 5 c.c. of yellowish brown, cloudy, thin fluid (Figs. 7 and 8).

Fig. 7. Case 11. Photograph of the excised heart, right lung, and a portion of the anterior bony chest wall showing the encapsulated abscess anterior to the ribs, which is communicating with the pericardial abscess.

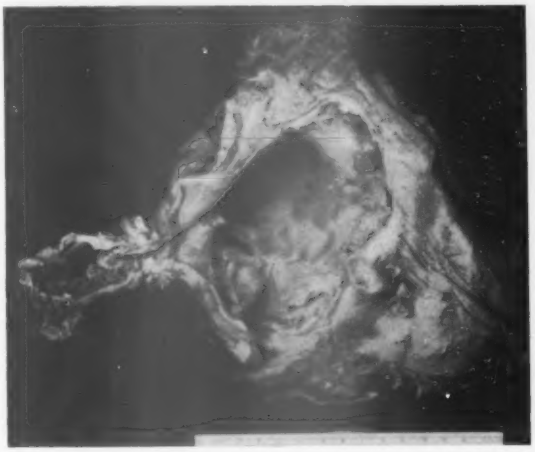

Fig. 8. Case 11. Showing the large pericardial abscess after the blunt removal of the anterior ribs. The sinus tract and the dissected subcutaneous abscess are pushed to the right.

CONCLUSIONS

Encapsulated pericardial effusions are most commonly situated on the right side of the heart. On roentgenologic examination they may be either hexagonal, semicircular or oval in shape. The cardiac pulsations are usually absent over the area of encapsulation. Occasionally, in the erect position, the lower border of the structure is separated from the lower border of the heart by an indentation. On inspiration the encapsulated effusion may become elongated, while in expiration it may broaden out, due to the stretching and relaxing effect of the mediastinal pleura.

The disease is commonly called inflammatory diverticulum of the pericardium, but it is not possible roentgenologically to determine whether the fluid forced the serous layer of the pericardium to herniate through the fibrous layer or whether the entire thickness of the pericardium formed the sac. This can be determined at operation or necropsy.

Two proved cases of right-sided encapsulated tuberculous pericardial effusion are reported to demonstrate the roentgenologic features of the disease. In the second case the pericardial abscess per-

forated into the subcutaneous tissues of the right anterior chest wall.*

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* For discussion see page 752.

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THE ROENTGENOLOGICAL DIAGNOSIS OF CARDIAC COMPRESSION DUE TO PERICARDIAL SCAR*

(ADHESIVE PERICARDITIS)

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IN THE roentgenological literature there are few publications on the diagnosis of pericardial adhesions and on the significant effects they produce on the configuration and physiology of the heart by compression of this organ. This apparent lack of interest can probably be best explained by the fact that the clinical aspects of the condition have not been generally known and that not infrequently the true significance of the symptoms has been recognized only at autopsy. The progress that surgery has made during the past few decades which made possible the necessary exploration of the heart in a case of cardiopericardial wound (by Rehn[13]) and, subsequently, the surgical extirpation of the pericardium (Rehn[14]), created greater interest in the difficult diagnosis of chronic pericardial disease.

Since the condition has become accessible to surgery, the early establishment of the correct diagnosis based upon the clinical and roentgenological examinations is just as necessary as the early establishment of the diagnosis of cancer. The disease of the pericardium eventually leads to a deterioration of the myocardium and the surgical response is far better in those cases where the myocardial involvement is slight.

The task of the roentgenologist in diagnosing this condition is at times even more difficult than that of the clinician because the useful signs may be quite inconspicuous. The disease may be masked by a small or approximately normal heart despite the clinical symptoms of cardiac decompensation. Only occasionally is there a moderately enlarged cardiopericardial shadow which might arouse suspicion. This discrepancy between the clinical symptoms of heart failure and the small, or slightly enlarged cardiac silhouette should arouse immediate suspicion of a compressed heart. Many of the remaining signs on which the diagnosis is based must be elicited instead of being found on casual roentgenologic examination.

PATHOLOGY, ETIOLOGY, AND CLINICAL SYMPTOMS

The condition under discussion is known by several names. The earliest reported case was probably the one reported by Van Deen,[18] in 1846, but a more complete description of the disease was given by Pick,[12] in 1896; under the title of "Ueber Chronische unter dem Bilde der Lebercirrhose verlaufende Pericarditis (pericarditische Pseudolebercirrhose)," (Pericardial Pseudocirrhosis of the Liver), now often called Pick's disease.

The disease is usually a sequel to an acute pericarditis associated with mediastinitis, although the signs of the acute stage may be obscure, and in a large number of cases no history of previous acute pericardial disease can be elicited. The acute inflammatory condition leads to a cicatrization of the pericardium, extensive adhesions between the pericardium and pleura, and, not uncommonly, to an obliteration of the pericardial cavity, giving the picture of so-called chronic mediastinopericarditis. Occasionally a distinction is made between two forms of the disease: in the first, internal adhesions are present between the leaves of the pericardium (concretio), and in the second, the

* Read at the Thirty-seventh Annual Meeting, American Roentgen Ray Society, Cleveland, Ohio, Sept. 29–Oct. 2, 1936.

adhesions develop between the pericardium and the neighboring organs (accretio). However, seldom is either of these two forms present as a clear cut entity and the combined forms are the most common. Furthermore, adhesions between the pericardium and pleura, or between the leaves of the pericardium are of little importance, since the clinical symptomatology of the condition is not caused by the adhesions, but by the pressure exerted by the thick pericardial scar on the heart. The heart becomes encased by a spheroidal scar of multiple layers, which, in turn, may, or may not, be adherent to the anterior thoracic wall, or to the posterior mediastinum. An adherent, but not thickened pericardium, not uncommonly found at the autopsy table usually has no influence on the action of the heart.

Histologically the scars may show evidence of tuberculosis, but, more commonly, the histologic evidence of tuberculosis is not present. Pneumonia and empyema are also important etiological factors and in at least 4 of our cases the development of pericardial scars could be definitely traced to a pneumonia probably associated with empyema and pericarditis.

In the patient's clinical picture, the marked discrepancy between the finding of severe circulatory failure and the meager objective cardiac signs predominates.

Due to compression by rigidity of the scar there is insufficient diastolic filling; the pulse is small in amplitude, soft, and diminishes with inspiration. The diastolic difficulty is indicated by the markedly enlarged neck veins, and the elevated venous pressure, which may rise to 30–45 cm. of water instead of the normal 1–4 cm. Such a marked elevation of the venous pressure is unusual without a great enlargement of the right heart, yet the right-sided enlargement is often absent. The stasis is not due to a disease of the heart itself; it is a stasis proximal to the heart (Volhard's[20] "inflow stasis"). The liver and spleen enlarge in response to the high venous pressure and become covered by a layer of fibrin and fibrous tissue.

Beck[2] compared the pericardial lesion, producing compression of the heart, with the intracranial tumor producing either acute or chronic pressure on the brain. He reduced the signs of compression of the heart to three components: (1) a high venous pressure, (2) a small, quiet heart and (3) ascites. All other clinical manifestations are secondary to this triad.

NOMENCLATURE

There is still considerable confusion concerning the nomenclature of this condition. "Adhesive pericarditis" is not a correct term, because the lesion is generally not an active inflammatory condition, but is the end-result of a previous inflammatory process. Furthermore, the clinical syndrome may occur without intrapericardial adhesions and, in turn, intrapericardial adhesions alone do not necessarily lead to the production of the syndrome. The term "Pick's disease" has to be defined to be understood and, by itself, gives no clue to the pathological anatomy or physiology of the disease. Beck[2] has suggested the term "compression of the heart due to pericardial scar," and it is felt that this term conveys the essential features of the disease both from the standpoint of pathology and physiology, and, if generally accepted, might obviate the present confusion.

TREATMENT

Two years after the publication of Pick's paper, Delorme,[8] basing his method of treatment on studies upon the cadaver, suggested the removal of a portion of the pericardium to free the heart from its encasing scar. His proposals met with slight favor, which is not surprising in view of the fact that as late as 1883, Billroth[4] stated that, "the surgeon who would attempt to suture a wound of the heart would lose the respect of his colleagues." Yet the time when this was to be attempted was not far away. Rehn,[13] in 1896, was the first to operate successfully on the human heart. His patient was stabbed by a dagger and developed a

hematopericardium. The wound in the heart was sutured and the patient recovered.

Brauer,[5] in 1902, was the first actually to attempt extrapericardial cardiolysis in man. He removed part of the sternum and the anterior ribs to lessen the resistance of the rigid thoracic cage against the systolic contraction. However, this procedure, which he called "extracardiac cardiolysis," did not improve the diastolic filling of the heart, the diminution of which is the major cause of the disease and the result obtained was not quite satisfactory.

Rehn is commonly credited with the accomplishment of Delorme's suggestions and in 1920 he reported the successful removal of parts of the pericardium in 4 cases.[14] Rehn's feat was subsequently repeated in several cases by his colleague, Schmieden.[15,16]

Churchill,[7] in 1929, was the first to perform the operation in the United States. His patient was an eighteen year old girl, who was in excellent condition at the time of the published report, a year after the operation. The second successful pericardiectomy in the United States was reported by Beck and Griswold,[1] in 1930, the operation having been performed on a fourteen year old boy in 1929. Today this patient is clinically well and is able to perform strenuous exercise, such as playing baseball.

Since his first case was reported, Beck has performed 13 additional pericardiolyses and one operation in a case of chronic encapsulated pericardial effusion, a total of 15 cases. Of these, 4 died at operation, or within twenty-four hours, a primary mortality rate of a little over 25 per cent. One patient died of an intercurrent disease two years later; his primary condition caused by extensive pericardial calcification was greatly improved. The remaining 10 have been under observation over a period of from a few weeks to seven years. Six of these showed marked improvement. One was found to have active pericardial tuberculosis at operation and has not shown improvement. In 2 cases the operation is too recent to permit an opinion as to the ultimate result.

ROENTGENOLOGICAL EXAMINATION

The present study is based on 14 cases of cardiac compression caused by pericardial scar. All of these patients were operated upon and in 3 of the 4 who died within twenty-four hours after operation, complete autopsy was performed.

The roentgenologist should be well informed of the clinical problem. Otherwise, firmly encased hearts without enlargement of the cardiac silhouette might escape detection. Roentgenoscopic examination in this condition is of considerably greater importance than roentgenographic, because by the former, important respiratory change in the position and configuration of the heart and diaphragms can be detected or elicited with ease. The roentgenograms are of importance as a record of the changes seen on roentgenoscopic examination and for cardiac measurements. Stumpf's[17] new method of kymography which is a composite moving picture and records in successive spaces on the roentgen film, events which occurred in succession of time, is a valuable diagnostic aid. It records the presence or absence of cardiac pulsations and the amplitude of the pulsations whenever they are present over certain sections of the heart. Stumpf demonstrated a case with reduction or flattening of the kymographic curve in the pulsating areas and the absence of the curve throughout the rest of the heart. Strangely enough, in his case, some of the areas of calcification in the left ventricular region showed pulsating excursions. This apparent contradiction he explained by the fact that the calcium may be deposited in very thin, interrupted layers, so that its mobility is not greatly impaired. One of the cases discussed here also showed pulsatory excursions in the region of calcification overlying the left ventricle.

Johnson[10] was the first in the United States to report on the value of the kymograph in diagnosing pericardial scars. His

case showed absence of the diastolic thrust of the pulse curve throughout the right border and throughout the left lower border of the heart, while in the region of the left auricle and descending aorta it showed a marked decrease. Another kymogram taken thirty-three days after pericardiolysis showed ample excursions of all parts of the cardiovascular shadow. At the University Hospitals the kymographic method was only recently introduced so that kymographic recordings were obtained in only a few postoperative cases, and in only 3 cases before operation.

In the roentgenological investigation of clinically suspected or diagnosed cases, the following diagnostic points are used: (1) the observation of the heart shadow and of the cardiac configuration; (2) roentgenoscopic determination of the presence or absence of pulsations, lately supplemented by additional kymographic studies; (3) the changes of the configuration of the heart in the inspiratory and expiratory phase with the patient in erect position; (4) the determination of the mediastinal excursions in the left or right lateral recumbent position during inspiration and expiration; (5) the change of relationship of the anterior border of the heart with the sternum during inspiration and expiration; (6) the appearance of the retrocardiac space as seen in the lateral view; (7) the appearance of the diaphragm and its relationship to the heart shadow; (8) the calcification of the pericardium.

Due to the fact that all these patients have a more or less marked ascites or effusion in the pleural cavities, the roentgen examination should be performed immediately after abdominal and pleural paracentesis.

In the individuals examined the compressed heart varied in size.

Of the 14 patients, 8 showed either an approximately normal heart or one somewhat smaller than normal. Of the remaining 6, four showed slight enlargement, and in only 2 cases was the cardiopericardial shadow fairly markedly enlarged. In none of the 14 cases was great enlargement found. The enlargement, if present, either involved equally both borders of the heart, or was represented as an area of bulging on either border of the cardiac silhouette, out of proportion to the size of the rest of the heart.

The configuration of the heart was also variable. One of the most commonly encountered features of these hearts was a peculiar, more or less marked, triangularity with the left and right borders showing some outward bulging, but without the normal two arches on the right and three arches on the left. This appearance of the cardiac silhouette was present in 7 of the 14 cases. An additional case showed a typical mitral configuration, including an apparent enlargement of the left auricle; yet no clinical signs or symptoms of a mitral disease were present. Of the remaining cases, 4 showed a slight, or fairly marked bulging in the region of the left ventricle, giving the heart an aortic configuration. Finally, in 2 cases, the enlargement was localized to the lower right cardiac border, while the rest of the heart contour was not enlarged.

All of the hearts showed some straightening out of the contour during inspiration, giving the appearance of stretching of the respective parts of the pericardium between two points of suspension.

The upper mediastinal shadow was of normal size in 8 cases. In 6 cases there was a moderate right-sided widening, due to an enlargement of the extrapericardial portion of the superior vena cava. The aortic knob was more or less markedly flattened or completely obliterated in all but one case, probably due to the compression effect of the scar.

On roentgenoscopic observation there was a remarkable lack of the motion phenomena about the heart. The pulsations were either absent or markedly diminished and hardly perceptible. Occasionally, in limited sections of the heart, most commonly in the region of the left ventricle, the pulsations were of normal amplitude.

None of the cases showed normal amplitude of the pulsations throughout the entire cardiac contour. The diminution of pulsation is in distinct contrast to the marked pulsations seen in a heart of corresponding size due to hypertrophy and slight dilatation. In cases of marked cardiac dilatation, the pulsations may be also diminished, but the compressed heart practically never dilates to a degree that would suggest cardiac failure due to dilatation.

In order to examine the plasticity and fixation of the heart, its configuration was observed during inspiratory and expiratory phase with the patient in erect position. Normally, as the diaphragm moves upward during expiration, the configuration of the heart changes. Both the heart and mediastinum become flattened and widened due to the upward movement of the diaphragm caused by its expiratory relaxation and by the increased intra-abdominal pressure. This normal response was not observed in any of the cases, and the configuration of the heart remained the same or changed but little during the two phases of respiration, indicating an excessive rigidity imparted to the heart by the thick scar. In some cases an upward tug on the heart was observed in the postero-anterior position, as described by Kornblum, Bellett and Ostrum,[11] and caused by the upward movement of the heart with the sternum to which it was adherent. This phenomenon could be observed more accurately in the lateral position.

The changes in the configuration and respiratory excursions of the heart in the left or right lateral position were determined under the roentgenoscope, by having the patient turn to the left and right as far as possible, and by obtaining roentgenograms in the left and right lateral positions during inspiration and expiration. There is a fairly general misconception as to the behavior of the heart and diaphragms when the patient is examined in the lateral recumbent position. Although it is true that the heart moves over to the side on which the patient lies, this excursion occurs only during the expiratory phase, while during inspiration the heart remains in normal position. Butler and Dana,[6] in 1928, and Zdansky,[20] in 1931, recommended the utilization of the respiratory excursions of the normal mediastinum in the roentgenological diagnosis of pericardial scars and adhesions described first by Hofbauer and Holzknecht[9] in 1907.

According to Hofbauer and Holzknecht, if the patient is placed in the left or right recumbent position, during deep expiration, both borders of the heart shadow move toward the dependent side, and slightly upward, while both diaphragms move upward. The upward movement of the dependent diaphragm is always more marked than that of the contralateral one. In addition, the heart shadow becomes widened, as during expiration in an erect position. In deep inspiration both the heart and diaphragm move back toward the midline and caudally. The heart becomes elongated and occupies a median position in very much the same way as during inspiration in the erect position. The respiratory excursion of the heart in the lateral position represents a rotation of the heart around a point which occupies the lowermost part of the dependent side. The forces which govern this motion in deep expiration are, according to Hofbauer and Holzknecht, the following: (1) the weight of the mediastinum itself; (2) the pulling effect of the liver, which because of being anchored to the central tendon pulls the heart; (3) the intra-abdominal pressure, which being increased on the dependent side and decreased on the opposite side, pushes the dependent diaphragm upward and pulls the opposite one downward at the same time. This force produces a dislocation of the central tendon and the heart toward the dependent side. These three forces contribute to the expiratory downward movement of the heart and mediastinum.

On deep inspiration, when the diaphragm contracts, the bundles of the lumbar and sternal sections of both dia-

phragms become shortened and pull the central tendon caudally, stretching the dislocated heart and mediastinum, and pulling it back to the midline. At the same time, the costal parts of the opposite diaphragm also pull the central tendon away from the dependent side, because the non-compressed half of the thorax is able to perform a more ample inspiratory excursion than the compressed dependent half. Consequently the mediastinal excursion in the lateral position, described by Hofbauer and Holzknecht, represents a return of the sunken mediastinum to the midline.

Butler and Dana,[6] as well as Zdansky,[20] observed that if the pericardium is adherent to the neighboring organs, the respiratory mediastinal excursions do not take place and the heart remains in the midline and although the diaphragms may move during respiration, the configuration of the heart shadow remains the same. According to Zdansky, the absence of the mediastinal excursions is indicative of adhesions between the pericardium and the neighboring structures, while the unchanged configuration of the heart indicates decreased plasticity due to pericardial scars, provided that the heart is not excessively large and there are no excessive indurative processes in the lungs, large amounts of fluid in the pleural cavities or pneumothorax. The respiratory excursions of the mediastinum in the lateral recumbent position were absent in 8 of the 14 cases, indicating a complete fixation of the mediastinum, while the remaining 6 showed a limited degree of excursions. The configuration of the heart and mediastinum remained the same or changed but little in all of the cases examined.

The presence or absence of adhesions between the heart and sternum was determined in the lateral erect position during inspiration and expiration. Normally, during deep inspiration, the sternum moves upward and away from the heart and the retrosternal space becomes wider as well as more radiolucent. If adhesions are present between the sternum and heart, the heart is seen to move upward in inspiration (Kornblum's[11] inspiratory tug), and widening of the retrosternal space does not take place. This sign was present in 8 of the 14 cases. In 1 case, despite the calcification of the anterior pericardial wall, the pericardium was not adherent to the sternum and the sternum was seen to move away from the calcified pericardial plaque during inspiration.

The retrocardiac space showed in every case a definite variation from normal, varying from a moderate, mottled cloudiness to a dense haziness, due to the mediastinal fibrosis.

The configuration and movements of the diaphragms were normal in 4 cases. The remaining ones showed either unilateral or bilateral pathologic changes, due either to pleurodiaphragmatic or pleuropericardial adhesions, represented by areas of flattening or areas of irregularities and limited or absent respiratory excursions.

Calcification of the pericardium occurred in 4 of the 14 cases. In 2 cases it was excessive, surrounding the entire right half of the heart including the diaphragmatic surface. In 1 case the calcification was moderate, involving the anterior inferior and posterior surface of the midportion of the heart, while the fourth case showed only a few linear areas of calcification along the left and right borders.

CASE REPORTS

We have selected a few cases to illustrate some of the clinical and roentgenological features of the compressed heart.

CASE 1. G. B., male, white, aged fourteen, complained of shortness of breath and swelling of the abdomen of two years' duration. Examination showed a markedly distended abdomen with the lower border of the liver situated about 5 cm. below the costal margin. The liver was tender. The veins were markedly dilated over the entire body. The heart sounds were distant and no cardiac impulse could be felt. The vital capacity was 32 per cent below normal. The venous pressure was 28 cm. of water at the level of the auricle. The blood pressure was 106/75.

Roentgen examination showed the heart shadow to be small and triangular in type. The mediastinum was slightly widened. The left border of the heart was almost straight, the right border was straight oblique (Fig. 1). No cardiac pulsations could be detected on roentgenoscopic examination. The heart showed a slight shifting during respiration in the left and right lateral positions, but no change in configuration. The diaphragms descended but slightly on deep inspiration with the patient in erect position. The widening of the retrosternal space was limited during deep inspriation. The retrocardiac space was cloudy. Both diaphragms were adherent in the costophrenic and cardiophrenic sinuses. The adhesions were more marked in the left. There were several calcified nodules in the left hilus. There was an azygos lobe in the right lung.

Pericardiectomy was performed by Dr. Beck on April 7, 1934. With the exception of the diaphragmatic surface on the left, the heart did not show any pulsations. The entire pericardial cavity was obliterated and sharp dissection was necessary to cut away the pericardium from the heart. Over the apex of the heart, the scar penetrated the myocardium, the myocardium being adherent to the scar

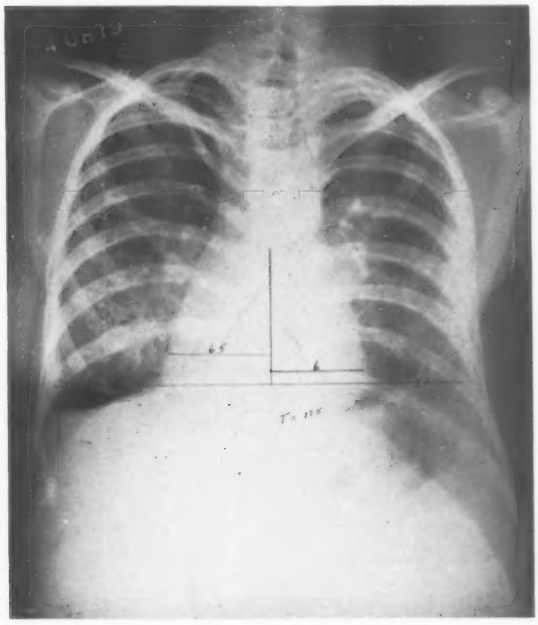

Fig. 1. Case I. Small triangular heart. The upper mediastinum is slightly enlarged to the right. Both borders of the heart are straightened. There is an azygos lobe on the right.

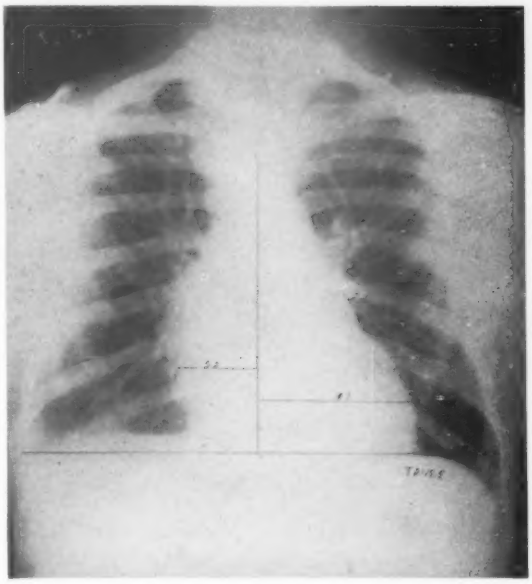

Fig. 2. Case II. The heart is bag-shaped and moderately enlarged. There is an abnormal outward bulge of the midportion of the right cardiac contour. The aortic knob is obliterated and the left upper cardiac contour is straightened out.

everywhere. The superior and inferior venae cavae were surrounded by scars. The pericardium over the anterior surface of the heart was resected. The resected scar measured 4 inches transversely and 5 inches longitudinally.

Since the operation there has been steady improvement in the patient's condition. The enlargement of the liver receded. One year after the operation the blood pressure was 112/78 and the apex impulse was forceful. The venous pressure decreased to 10.5 cm. of water.

Roentgenoscopic and kymographic examination on April 24, 1936, two years after the operation, showed the appearance of the heart to be essentially the same, although the regions of the left and right ventricles showed some increased bulging. Only the pulsatory phenomena showed a remarkable change from the postoperative appearance. They were vigorous on the left and present, but of small amplitude, on the right.

Clinically the patient is remarkably well more than two years after operation. The abdomen is flat and the veins of the body are only slightly distended.

Case II. H. T., male, white, aged thirty-seven, was admitted complaining of cardiac palpitation, mainly at night, and pain radiating

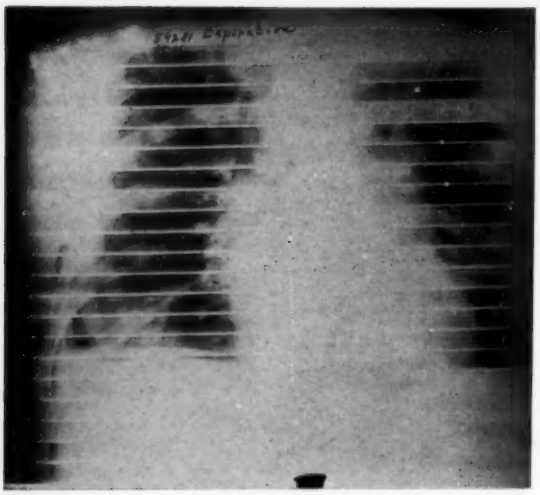

FIG. 3. Case II. Kymogram showing absent pulsations over the entire right cardiac contour. The pulsations on the left cardiac border are normal.

to the left shoulder, of eight months' duration. He had had repeated abdominal tappings since the onset of his illness.

Examination showed the heart sounds at the base to be relatively faint. The abdomen showed a bilateral bulging in the flanks. The liver edge was situated 10 cm. below the costal margin. The veins of the neck were slightly enlarged. The blood pressure was 100/70 and the venous pressure 20 cm. of water.

Roentgenological examination showed a bag-shaped, moderate enlargement of the heart shadow, with a suggestive mitral configuration. The upper left cardiac contour was straightened. There was an abnormal outward bulge of the midportion of the right cardiac contour (Fig. 2). The pulsations of the left border of the heart were of normal amplitude and normal in rhythm. The right border of the heart was immobile. Kymograms confirmed this roentgenoscopic finding (Fig. 3). The posterior mediastinum was cloudy. The anterior lower portion of the pericardium, at about the midline, showed a longitudinal plaque of calcification (Fig. 4). Both diaphragms moved normally. There was a slight amount of fluid at the right base. In the right lateral recumbent position, both diaphragms moved normally and the heart moved in slightly toward the dependent side. The configuration of the heart changed slightly during the respiration in both the erect and lateral recumbent positions. With the patient in the lateral position, the heart, as well as the calcified plaque of the pericardium, moved away from the sternum.

Pericardiolysis was performed by Dr. Beck on July 25, 1936. The right border of the heart showed no pulsatory motions, and the left border showed increased pulsations. A hard, calcified mass measuring 4 cm. in diameter could be palpated on the anterior aspect of the heart. The pericardial scar measured 2 to 3 mm. in thickness. The scar was adherent to the myocardium. One of the calcified plaques extended into the myocardium, and could not be removed from the ventricular wall. The scar over the left and the right ventricle was resected.

CASE III. M. F., female, aged twenty-three. This patient had influenzal pneumonia, complicated by pericarditis twenty months prior to admission. The pericardium was repeatedly tapped at that time. The fluid obtained was sterile. Four months after the onset of the illness the abdomen began to increase in size. She had an exploratory laparotomy eight months before admission. The abdomen was found to contain large amounts of straw-colored fluid.

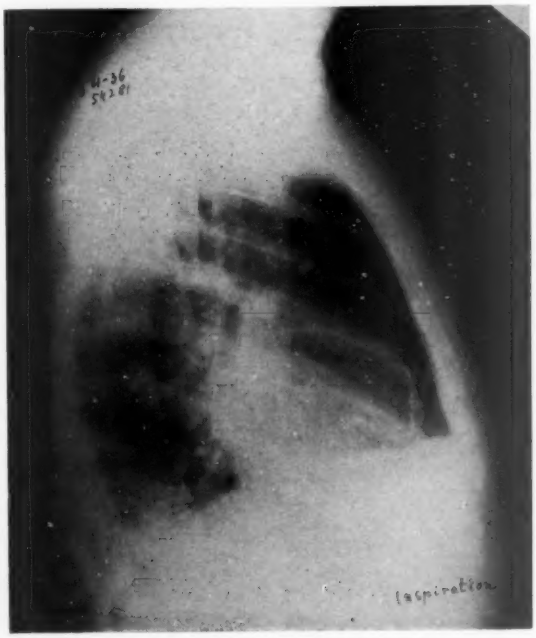

FIG. 4. Case II. Inspiratory lateral view showing the retrosternal space to be air-containing, indicating the absence of adhesions between the sternum and the heart. The anterior pericardium contains a calcified plaque. The posterior mediastinum is cloudy.

The patient had abdominal paracenteses at two to three week intervals.

Her color was pasty, the lips and fingernails were cyanotic, the veins of the neck were prominent, showing pulsations, and the veins of the forehead stood out. The eyegrounds showed engorgement of the retinal veins. The abdomen was distended and the lower border of the liver was situated about 3 cm. below the costal margin. The blood pressure was 98/78 and the venous pressure equalled 27 cm. of water.

Roentgenologically, the heart was of approximately normal size. While the upper left cardiac contour had a straight outward, oblique course the ventricular contour took a sharp, downward and inward course, with the production of a triangular irregularity at the apex. The right contour showed a slight enlargement in the region of the superior vena cava (Fig. 5). The pulsations were absent in the region of the left ventricle and were markedly diminished on the right side. The heart showed no respiratory excursions in either the erect or recumbent lateral positions. The retrosternal and retrocardiac spaces were hazy and the heart moved upward with the sternum on deep inspiration (Fig. 6.)

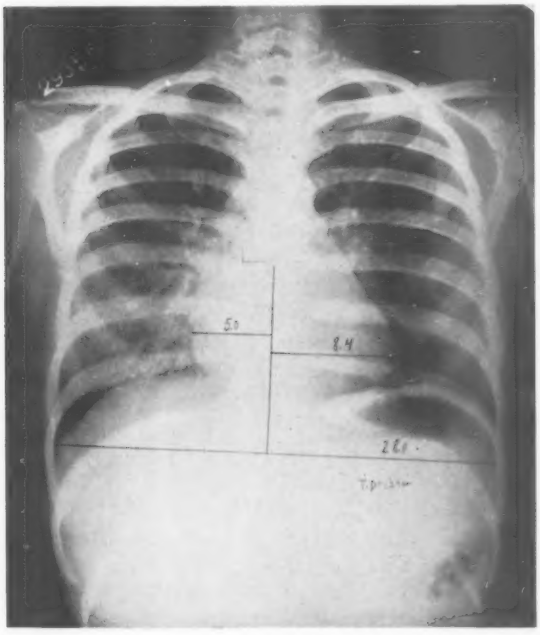

Fig. 5. Case III. Approximately normal-sized heart. The left upper cardiac contour has a straight oblique course. There is an abnormal outward bulge in the midportion of the right cardiac silhouette. The shadow of the vena cava superior is slightly enlarged.

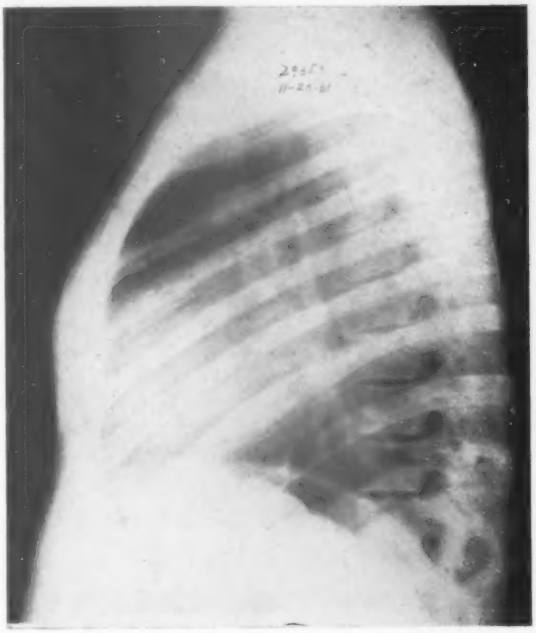

Fig. 6. Case III. Inspiratory lateral view showing a complete obliteration of the retrosternal space, indicating adhesions between the sternum and heart. The midportion of the posterior mediastinum is cloudy.

Pericardiectomy was performed by Dr. Beck on November 25, 1931. Over the outer surface of the pericardium strands of scar tissue were seen extending to the sternum. The heart appeared to be at a standstill from the outside. The pericardial scar measured 1.5 cm. in thickness. There was a thick scar around the superior vena cava. Laterally, and to the right, the scar was so tough that the pericardium had to be removed by sharp dissection for fear that by blunt separation the myocardium might tear. The right auricle was torn and the bleeding was finally controlled by clamping.

The patient died eight hours after the operation. The important feature of the necropsy was that the heart was completely free from its anterior pericardium. The heart was small and both the mediastinum and the pericardium showed marked thickening due to connective tissue proliferation (Fig. 7).

Case IV. E. C., male, aged fifteen, was admitted complaining of weakness, shortness of breath on exertion, cyanosis, puffiness of the face and eyelids, swelling of the abdomen and of the extremities. Six years before admission he had developed a pericarditis following pneumonia. His pericardial cavity was tapped

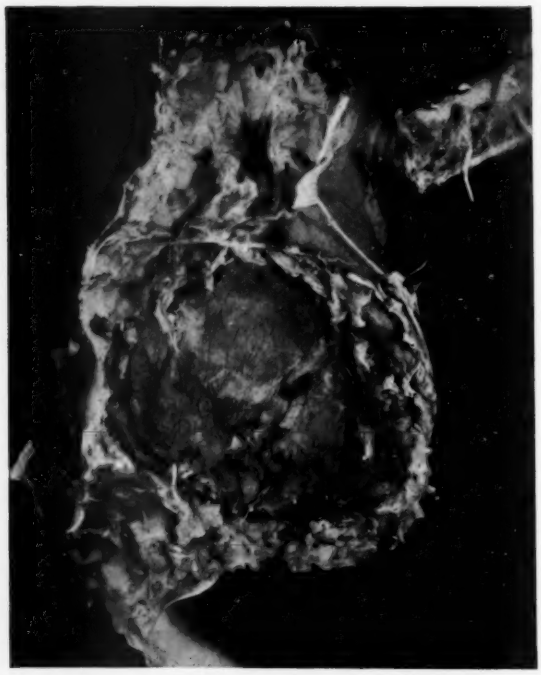

FIG. 7. Case III. Necropsy specimen showing the operative defect of anterior pericardium. The pericardium is greatly thickened. The thickening extends over the great blood vessels.

fifty-three times during the ensuing two years and each time about 1,000 c.c. of clear to straw-colored fluid was withdrawn. The fluid contained no tubercle bacilli and guinea-pig inoculation of the fluid failed to produce tuberculosis. Finally four years before admission an attempt was made elsewhere to obliterate the pericardial cavity by the intrapericardial injection of gentian violet. The accumulation of the pericardial fluid stopped, with the gradual development of the following symptoms: weakness, swelling of the abdomen and extremities, shortness of breath on exertion, cyanosis and puffiness of the face and eyelids.

On admission, the apex beat of the heart could not be palpated. The heart sounds were regular, but distant. The jugular veins of the neck were distended and pulsated with the auricular pulsation of the heart. The veins of the arms were distended. The abdomen was enlarged and the lower border of the liver was situated 9 cm. below the costal margin. The

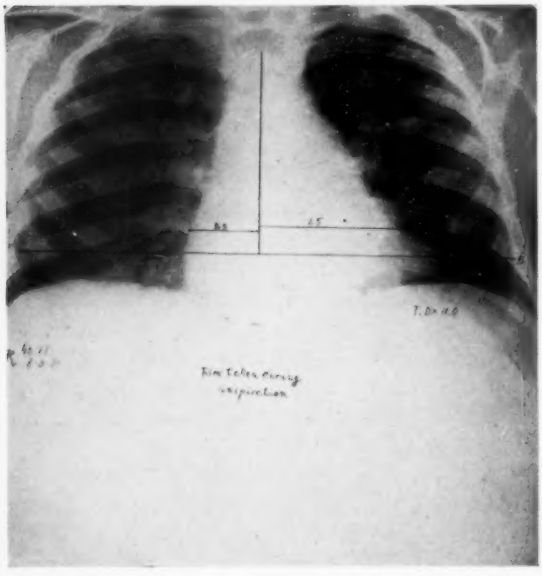

FIG. 8. Case IV. Inspiratory anteroposterior erect film showing the heart shadow to be small, triangular. The left ventricular contour is irregular, indicating pericardiopleural adhesions.

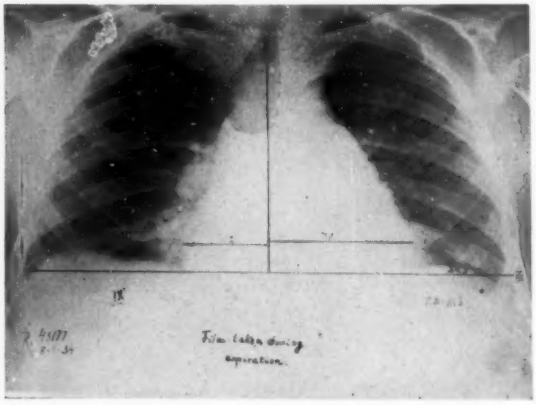

FIG. 9. Case IV. Expiratory anteroposterior erect film showing the size and configuration to be the same as in inspiration. Absence of the normal respiratory response, due to the scar.

blood pressure was 100/70. The venous pressure was equal to 20 cm. of water.

Roentgenologic examination showed a small triangular heart (Fig. 8). The pulsations were superficial throughout its left border and absent throughout the right border. There was no change in the cardiac configuration during inspiration and expiration in either the erect or the lateral recumbent positions (Figs. 9 and 10). There was irregularity of the left ventricular contour on inspiration due to pericardiopleural adhesions. The heart was fixed. Both diaphragms moved normally. On inspiration the heart moved away from the sternum.

The operation was performed on September 10, 1934. The heart beat was definitely reduced in amplitude. The pericardial scar measured

3 to 4 mm. in thickness and was adherent to the pleura. Line of cleavage was obtained between the pericardium and myocardium, but during the dissection of the scar the patient died on the operating table, in ventricular fibrillation. Microscopically, the excised scar was composed of a cellular connective tissue.

Case v. B. S., female, white, aged fifty-four, was admitted complaining of shortness of breath, swelling of the ankles and occasional substernal pain of nine months' duration.

Examination showed a dilatation of all neck veins and of the veins of the anterior thorax and both extremities (Fig. 11). The liver extended about 3 cm. below the costal margin. The heart rhythm was irregular with an occasional drop beat. The blood pressure was 104/90 and the venous pressure equalled 21 cm. of water.

On roentgen examination the heart shadow appeared to be moderately enlarged to the left. The right cardiac border was straight. There was a longitudinal calcified plaque in the upper portion of the left ventricular contour and a horizontal calcified plaque at the basal portion of the left ventricle. The pulsations were absent in the region of the apex and diminished in the region of the incisura. There were no demonstrable pulsations on the right. The configuration of the heart remained the same during inspiration and expiration in the erect and both lateral recumbent positions. The heart moved in to the left on expiration in the left lateral recumbent position, but did not move to the right in the right lateral position. The heart was adherent to the sternum and moved upward with it during inspiration (Fig. 13). The left diaphragm moved away from the heart during inspiration, but the medial portion of the right diaphragm was adherent to the pericardium. The right diaphragm was likewise adherent in the costophrenic sinus. The mediastinum was slightly widened in the region of the superior vena cava. There were calcified plaques in the anterior, diaphragmatic surfaces along the left border of the heart. The posterior mediastinum was cloudy. There was a mottling throughout the base of the right lung, probably due to the chronic passive hyperemia.

Pericardiolysis was performed by Dr. Beck on November 10, 1934. The heart enclosed in the scar showed no pulsatory excursions. There

Fig. 11. Case v. Infra-red photograph showing enlargement of the veins of the neck, trunk and upper extremities.

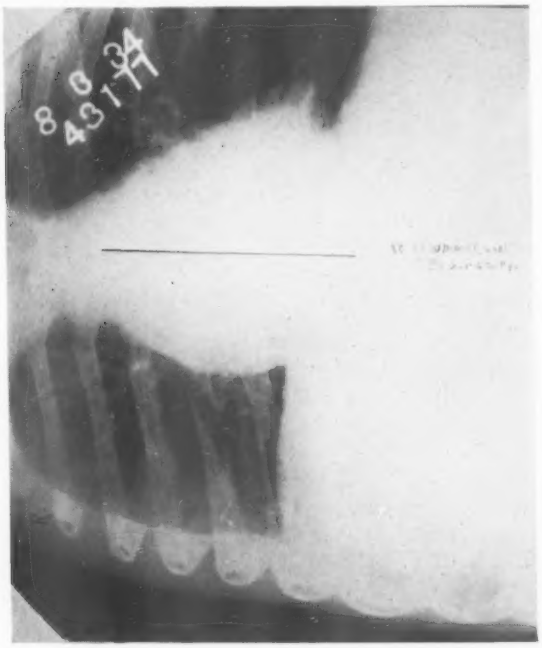

Fig. 10. Case iv. Expiratory anteroposterior film taken with the patient in the right lateral recumbent position. The heart remains in the midline and its configuration is not changed, indicating fixation.

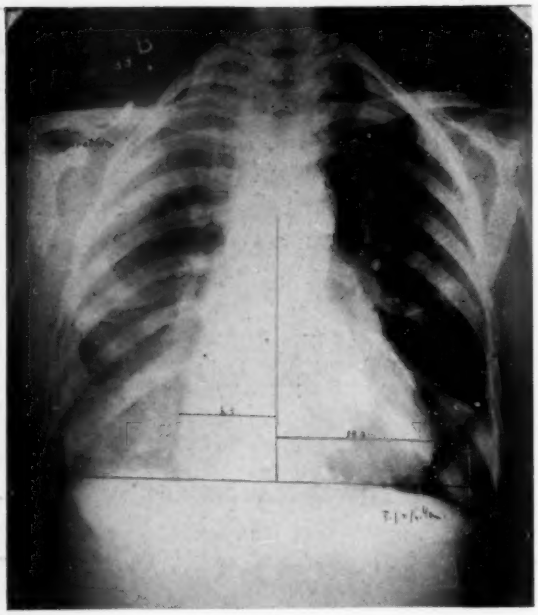

FIG. 12. Case v. The heart shadow is moderately enlarged in the region of the left ventricle. The right cardiac contour is straightened out. There are calcified plaques at the left lateral border and at the left diaphragmatic surface of the heart.

was no excursion whatsoever. The pericardial cavity was obliterated everywhere by adhesions. The anterior portion of the scar was resected and, after resection, the incised margin of the scar retracted well. After the heart was freed, it bulged through the wound. The scar measured 5–6 mm. in diameter.

The patient returned for a re-examination on September 2, 1935. She had been up and around the house daily, doing routine light housework. Blood pressure at this time was 120/80. There was no cyanosis, the veins of the neck were almost normal.

A kymogram was taken on June 26, 1936, which showed vigorous pulsations throughout the left side and superficial pulsations on the right. The calcification in the left ventricular region was still visible. At this time the patient stated that she was employed as a laundress during five days of every week and was able to carry on the heavy work without any discomfort.

CASE VI. G. R., male, aged twenty-eight, had enlargement of the abdomen and scrotum, palpitation of the heart, and shortness of breath of eight years' duration. The patient had had a laparotomy seven years previously for an assumed tuberculous peritonitis. Following this operation the abdominal fluid reaccumulated very rapidly, necessitating abdominal paracentesis every three weeks.

On admission the skin was found to be pallid and dilated veins were visible over the arms, legs, face, neck, and scrotum. There was cyanosis of the lips and fingernails. The heart sounds were distant and there was a systolic retraction of the left lower anterior chest wall. The abdomen was large. The lower border of the liver extended about 3 cm. below the costal margin. The vital capacity was 60 per cent of normal. The blood pressure was 96/77. The venous pressure equalled 27 cm. of water.

Roentgenologically the heart was bag-shaped and slightly enlarged to the right. The aortic knob was absent and the shadow of the vena cava superior was slightly prominent (Fig. 14). The pulsations were absent throughout. There was an extensive calcification around the right and left borders of the heart and throughout its diaphragmatic surface (Fig. 15). The heart was rigid and remained unchanged during both respiratory phases in the erect and in the recumbent positions. There was evidence of

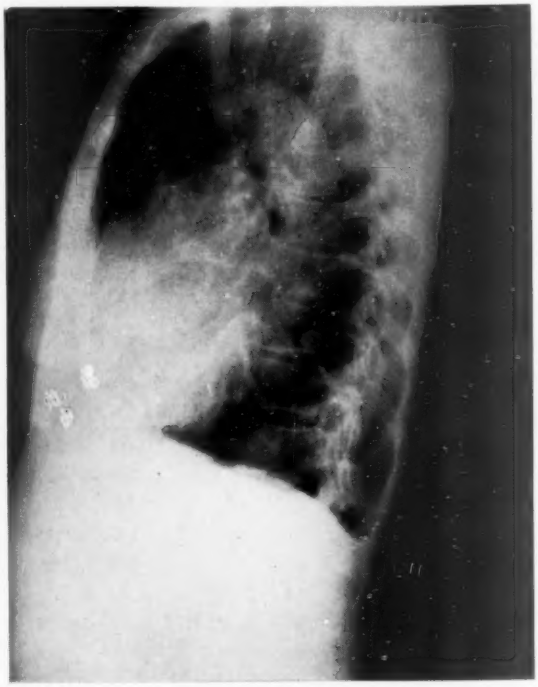

FIG. 13. Case v. Inspiratory lateral view demonstrating extensive adhesions between the pericardium and sternum. The midportion of the posterior mediastinum is cloudy.

pleural fluid at the left base, obliterating the diaphragm. The right diaphragm was adherent in the costophrenic sinus. It was likewise adherent to the right border of the heart. The sternum did not move away from the heart on deep inspiration, indicating pericardiosternal adhesions.

Pericardiolysis was performed by Dr. Beck on July 31, 1933. The heart was found encased in calcified pericardium. The calcium could be cracked off in masses. Because of the dense adhesions, the separation had to be carried out by sharp dissection. The calcified scar measured, in places, over 1 cm. in thickness and, at the basal portion, the pericardium and diaphragm were fused. Nevertheless, it was possible to resect the entire anterior portion of the calcified pericardium and improvement was noticed immediately after operation. The pulse pressure widened.

On April 13, 1934, the patient showed no cyanosis or shortness of breath. He had been able to climb mountains without fatigue. The blood pressure was 110/70 and the venous pressure 17 cm. of saline.

He was readmitted on May 6, 1935, complaining of weakness and continuous vomiting of two weeks' duration. Shortly before the onset of this illness he and two of his companions became ill after eating fish, one of them dying subsequently. The patient drove to Cleveland from West Virginia in his automobile and died two hours after arrival at the hospital. Necropsy was performed.

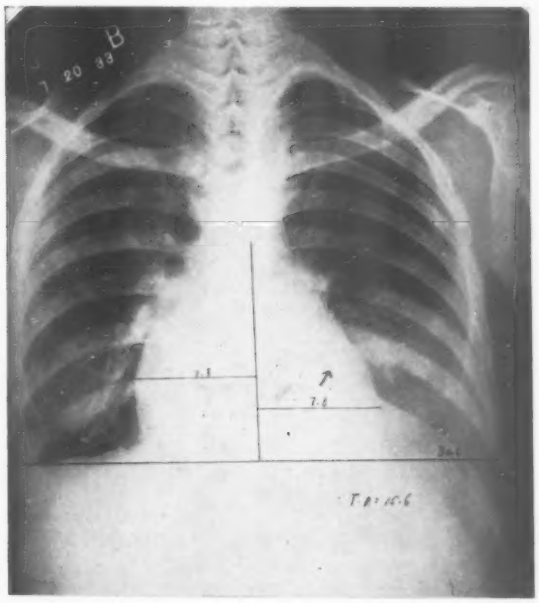

Fig. 14. Case VI. Bag-shaped heart which is slightly enlarged to the right. Some prominence of the vena cava superior shadow. The aortic knob is absent. There is a calcified plaque medial to the left lateral border of the heart (arrow).

Fig. 15. Case VI. Inspiratory lateral view demonstrating the extensive calcification of the pericardium. Retrocardiac space is clear. Retrosternal space is almost completely obliterated.

CONCLUSIONS

The roentgen diagnosis of cardiac compression due to pericardial scar tissue formation is made by the utilization of several signs, the most conclusive of which is the pericardial calcification. Aside from this latter, only the finding of several of the individual signs justifies one in making an unequivocal diagnosis. The roentgenoscopic examination is of greater importance than roentgenographic because important respiratory changes in the position and configuration of the heart and diaphragm can be elicited with ease. The knowledge of the clinical history is important, because

it leads to a search for some of the signs which are not obvious and have to be elicited. One of the most important signs is the marked discrepancy between the clinical symptoms of cardiac decompensation and the absolutely or relatively small shadow of the heart. A marked enlargement of the cardiopericardial shadow is rare.

The cardiac configuration is variable. The triangular-shaped heart is common, while others show an abnormal bulging on either the left or right contour. The cardiac pulsations are abnormal. They are either diminished in amplitude or absent throughout the entire heart or throughout certain sections as seen by roentgenoscopic observations and by kymographic studies. Similarly, abnormal pulsations can be found in pericardial effusions and in cases of decompensation due to cardiac dilatation. However, the compressed heart is rarely large enough to suggest either of these two conditions.

The lack of plasticity and the presence of fixation of the heart are determined by examination during the inspiratory and expiratory stage with the patient in erect posteroanterior and lateral positions and in both lateral recumbent positions in posteroanterior direction.

Calcification of the pericardium which is one of the most conclusive single signs, is present only in the minority of cases.

We wish to express our appreciation to Dr. Claude S. Beck for the use of his clinical material in connection with this paper.

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DISCUSSION OF PAPERS BY DRS. SCOTT AND MOORE, AND FREEDMAN

DR. SYDNEY E. JOHNSON, Louisville, Ky. I wish to thank Drs. Moore and Scott for inviting me to open the discussion of their interesting contribution to roentgen kymography. I have been experimenting with kymography since the fall of 1934 and have found the method not only interesting, but, on several occasions, it has furnished the key to the diagnosis of otherwise doubtful cases. Such a case—constrictive adhesive pericarditis—was reported in *Surgery, Gynecology and Obstetrics*, August, 1935, and is of interest in connection

with the case reported by Dr. Freedman. I believe that Dr. Freedman would get better results if he would change his kymograph to move the film instead of the grid.

Roentgen kymography has two well-defined fields of usefulness, one in practical roentgen interpretation, and the other in the field of investigation. The work which Dr. Scott has just reported appears to me to fall in the latter category, although the two will interdigitate more and more as we acquire greater proficiency in the interpretation of kymographic records.

It is of interest to note that the method was given to roentgenology by a physiologist and now bids fair to be given back to physiology by the roentgenologists, in a greatly improved form.

I feel poorly qualified to discuss Dr. Scott's paper as I have made no kymographic studies of the movements of the thoracic wall, mediastinum, or tracheobronchial tree. Respiratory movement is, however, definitely related to the hemodynamics of the pulmonary circulation, blood pressure, and heart output. In relation to heart output I have made some observations which may be of interest.

The kymogram, as you have seen, records the cardiac silhouette in complete systole and in complete diastole, with intermediate stages of the cardiac cycle represented by curved lines. The thrust of the left ventricle may be measured in all the ventricular bands on the left border of the cardiac silhouette. It is found to vary under different pathological and physiological conditions. The left ventricle is treated as a cylinder of a diameter equal to six-tenths the total transverse diameter of the heart, and of a length equal to the distance between the highest and the lowest ventricular bands. From these measurements the difference in systolic and diastolic volume of the left ventricle is computed. This product should positively not be called stroke volume or beat output. We have chosen to call it the roentgen kymographic heart index, or to abbreviate, the RKG index.

We have found the RKG index to parallel stroke volume rather closely in normal subjects, and to deviate significantly from stroke volume in subjects with certain types of cardiac disease. Our observations have been controlled by the dye injection method of output determination as developed by Drs. John W. Moore and J. M. Kinsman. To date we have made observations on only 10 patients, including normal subjects and patients with mild and malignant hypertension, advanced rheumatic heart disease, and adhesive pericarditis. The work must be greatly extended before we can estimate its value.

DR. W. B. FIROR, Baltimore, Md. Dr. Freedman's enlightening paper serves to emphasize the value of a more comprehensive cardiovascular roentgen examination than that carried out at the present time by the majority of roentgenologists. Among many of us a lack of time or purpose results in a limitation to a teleroentgenogram which is frequently misleading. Inaccuracies of as much as 12 per cent in heart size alone have been recorded by this isolated study. It should be superfluous to indicate the necessity of fluoroscopic study as a preliminary procedure, and its value is well demonstrated in this report on the findings on adherent pericardium. However, when one is concerned with pulsatory phenomena, such a method of examination, even at the hands of ultra specialists, gives fleeting and often confusing impressions. In such a case, the roentgen kymographic observation plays the dominant rôle, as the degree and the interrelationship of cardiovascular movements are permanently recorded or "frozen" on the film.

Fluoroscopic and roentgenographic examinations in the variety of positions and respiratory phases suggested by Dr. Freedman yield much valuable evidence, although the presence of a small triangular cardiopericardial shadow showing little or no pulsation in a patient with outspoken caval stasic symptoms appears sufficient to establish a diagnosis of thickened and compressive pericardium.

In differentiating between cardiac aneurysms and encapsulated pericardial effusions, Dr. Freedman failed to mention the fact that in the former one may find a diastolic expansion in the aneurysm synchronous with ventricular systole elsewhere.

Finally, in expressing appreciation of Dr. Freedman's salutary discussion, I hope that we shall be pardoned for making a few suggestions which seem worthy of consideration, namely, that the tube, the anatomical part and the film be maintained in the same straight line for all positions described; that the kymograph should be turned until the slits are vertical in order to study the probable increased vertical motion of

the heart in patients with compressive pericardia, and that the teleroentgenographic exposures be made during only moderately deep inspiration.

DR. CLAUDE S. BECK, Cleveland, Ohio. The roentgenologist can lend a helping hand to the clinician in the recognition of compression of the heart. I might add that the clinician needs a helping hand in recognizing some of these syndromes. The cases of cardiac compression are not as rare as we think they are. They occur, I shall not say frequently, but they do occur, and, unfortunately, I believe the vast majority of them are not recognized.

I should like to present to you the concept of the compressed heart. The compressed heart is the opposite of the dilated heart. The dilated heart is a medical disorder, i.e., it is treated by medical measures. The compressed heart is a surgical disorder. Some of these cases yield beautifully to operation. Cardiac invalids have been restored to perfect health. The diagnosis, therefore, becomes a matter of great importance. The compressed heart cannot dilate. It cannot undergo hypertrophy. It is a small, shrunken organ. The compressed heart also undergoes disuse atrophy. This is a new idea, so far as the heart is concerned. It takes a long time for the compressed heart to recover after the compression scar has been dissected from the heart. At the operating table we see an immediate improvement which occurs when the heart is released from the compression. It is very dramatic to see the heart dilate and take a larger quota of blood with each stroke. Some of this immediate improvement is lost after the operation because the myocardium is not strong enough to pump this larger quota of blood. As a rule, the patient loses ground after the operation and then weeks later, gradually improves. This delayed improvement is due to recovery of the myocardium from disuse atrophy. The myocardium undergoes disuse atrophy in exactly the same way as does a skeletal muscle placed in a cast.

I have described two triads for cardiac compression that are helpful in diagnosis. The acute cardiac compression triad consists of (1) a small, quiet heart, (2) a rising venous pressure and (3) a falling arterial pressure. Acute compression is produced by fluid or gas or both pressing upon the heart. Blood from a stab wound of the heart, from a rupture of a myocardial infarct or from a contusion of the heart or a hemorrhage from a dissecting aneurysm of the aorta are the usual conditions in which acute compression develops. It may develop in acute purulent pericarditis.

The chronic cardiac compression triad consists of (1) a small, quiet heart, (2) a high venous pressure and (3) ascites and a large liver. Scars or fluid are the usual anatomic lesions producing chronic compression. A neoplasm, a localized abscess, a slow hemorrhage may produce chronic compression.

The key to the diagnosis is the small quiet heart. The quiet heart is sometimes apparent by inspection of the precordium. The precordium is quiet; there is little or no pulsation. Certainly, a precordial heave is never seen in a patient with a compressed heart. This fact in itself ought to mean something to the internist and ought to stop the surgeon from accepting the wrong patient for operation. An amazing number of mistakes have been made by people who should know better. The fluoroscopic examination gives unmistakable evidence of greatest importance in the reduction of diastolic-systolic excursions. Evidence of restricted pulsation together with the other clinical manifestations, as indicated in these triads, are unmistakable so far as diagnosis is concerned.

I should like to direct your attention to a common mistake. We commonly refer to the silhouette behind the sternum as the heart shadow. This is not correct. In normal conditions this statement is essentially correct, but if a pericardial scar is present or if fluid is present in the pericardial cavity, a large part of the shadow is produced by something other than the heart. The heart, per se, is always small. If this differentiation between the heart, per se, and the so-called heart shadow is kept in mind, mistakes will be reduced.

Adhesions play no part in the compression syndromes. We still hear good clinicians and good roentgenologists use the term "adhesive pericarditis." Adhesions to the heart are silent. They play no part in the production of the compression syndromes. I have demonstrated this fact both experimentally and clinically. Fixation of the heart in the mediastinum also has no significance either in the production of the syndromes or in the type of operation that should be carried out. I should also like to state that cardiopericardial adhesions do not play any part in the production of cardiac hypertrophy. The opposite belief has been widely taught and accepted. We cannot produce car-

diac hypertrophy by making the heart become adherent to the diaphragm or chest wall. Adhesive pericarditis, constrictive pericarditis, etc., are not good terms. They do nothing but add to the confusion. They refer to the presence of adhesions and to an old inflammatory process. We know first that adhesions play absolutely no part in the compression syndromes and, secondly, we know that infection or inflammation may be absent in the compression syndromes. A tumor or the pressure of blood can give compression. Someone calls it constrictive pericarditis; someone calls it Pick's disease, polyserositis, Concato's disease, mediastinopericarditis and so on. Someone else calls it a large, dilated heart with failure. The point that I am trying to make is this: we should recognize, first, the clinical manifestations of the compressed heart. The roentgenologist can see the reduction in the pulsation, the reduced excursions and, sometimes, he can determine that the heart is actually small. Here is an opportunity for the roentgenologist to instruct the internist and the surgeon what is meant by a small, quiet heart. The next step is to determine the anatomic lesion that produces the compression, whether it is fluid, blood, neoplasm, scar tissue, etc. This can be done with precision and the nature of the anatomic lesion determines the type of treatment.

Dr. Scott (closing). Dr. Johnson aptly mentioned that kymography provides information of two sorts: first, information of a strictly physiological nature, and second, information of a strictly clinical nature. While this is true to a certain extent, we should remember that kymography is primarily a record of physiological movement and will record only those variations in which the pathological process results in a different movement. This fact is particularly well illustrated in the films shown by Dr. Freedman. If the movement is sufficiently altered from the normal so that it can be detected on the film, then the method at least supplies additional information which may be of physiological interest, or of clinical value.

Dr. Freedman (closing). It was a great privilege to have had the opportunity of examining these cases studied clinically and operated upon by Dr. Beck. When I arrived at the University Hospitals two years ago, I knew little about cardiac compression and less about its roentgenological signs. However, after studying the previous cases and examining personally the subsequent ones, I now realize that by careful roentgenological study not only the clinical diagnosis of cardiac compression can be confirmed or rejected, but, not uncommonly, even an independent diagnosis can be made.

I should like to call your attention to a very important factor in these examinations. These patients usually have large amounts of fluid in both pleural and in the abdominal cavities. As much of the fluid should be removed as possible before the final examination is made, so as to restore the physiological relationship of the different organs and to avoid false positive signs.

OBSTRUCTION AT THE URETEROPELVIC JUNCTION DUE TO ABERRANT BLOOD VESSELS*

By CHARLES A. WATERS, M.D.
BALTIMORE, MARYLAND

WHILE the subject I have taken for my presidential address is not new, it is one which I believe is not as thoroughly understood by roentgenologists as it should be, and owing to the fact that many of these cases are first seen by the roentgenologist, it occurred to me that a discussion of this subject might lead to a clearer understanding of this condition and earlier diagnosis.

The purpose of this talk is to bring out the following points:

(1) The relative frequency of this condition.
(2) The inconspicuous, though almost constant, clinical symptom of pain.
(3) The early pyelographic signs.
(4) The variable age incidence.
(5) The operative relief and results.

In 9,955 admissions to the Brady Urological Institute of the Johns Hopkins Hospital, dating from June 1, 1925, to June 1, 1936, 4,116 had plain roentgenograms or pyelograms. Of this number, 528, or, 12.8 per cent, were hydronephrotic; 98, or 18.5 per cent, of these showed evidence of constriction at the ureteropelvic junction with hydronephrosis; 15, or 3.3 per cent, revealed nephroptosis without hydronephrosis, but with constriction at the ureteropelvic juncture. Therefore, a total of 113 cases out of 528, or 21.4 per cent, showed definite roentgenological evidence of obstruction at the ureteropelvic junction.

Four cases of horseshoe kidney were found with aberrant blood vessels producing hydronephrosis on one side, while 2 cases were complicated with stones.

Sixty-one of the 113 cases diagnosed clinically and roentgenologically as obstructions at the ureteropelvic junction, probably from aberrant blood vessels, came to operation and were verified. Nineteen, or 32.1 per cent, of these 61 proved cases revealed complete destruction of the affected kidney, nephrectomy being necessary.

In reviewing the literature on this subject which I have appended, but referred to in brief, one is forcibly impressed by the paucity of articles in English and these deal chiefly with a debatable discussion of the surgical relief afforded these cases. None were written from the standpoint of the roentgenologist, yet I believe in the future most of these cases will be discovered first by the roentgenologist. Since so many of these cases in the early stage have pain, but otherwise negative urinary findings, I was motivated to write on this subject.

Hinman[10] states that accessory blood vessels are a frequent cause of hydronephrosis and reports that Schmidt in 1930 found 6 out of 16, or 37.5 per cent, of the patients operated upon for hydronephrosis had constrictions at the ureteropelvic junction due to aberrant blood vessels.

Hinman further reports that in a postmortem study of 168 kidneys, 74, or 44 per cent, had anomalous blood vessels. In 25 of these the vessels went to the lower pole, in 33 to the upper pole. The ureter was posterior to the vessels in 72 per cent, which helps to explain the mechanics for the production of the obstruction. Anomalous veins were only about one-third as common as anomalous arteries.

From the above study it is quite evident that this condition is fairly common and that an early diagnosis must be made in order to avoid the possibility of complete destruction of the kidney.

* Presidential Address delivered before the Thirty-seventh Annual Meeting, American Roentgen Ray Society, Cleveland, Ohio, Sept. 29–Oct. 2, 1936.

At present, we have in our series 23 cases in which roentgen studies have been made before and after operation. It is now felt with reasonable assurance that from the roentgen study alone, i.e., intravenous and retrograde urography, it is possible to predict with fair accuracy whether the kidney function can be restored by paying particular attention to the amount of cortex remaining between the outer margins of the minor calyces to the capsule.

Pain. Undoubtedly pain is the early and predominating symptom and was present in 78.7 per cent of our cases. Its character is dull and non-radiating. In the bilateral cases pain was present on both sides. It varied in 70 from an insignificant intermittent dull ache to an acute pain in the back requiring hypodermic administration of narcotics. It was interesting to note in our series that the type and severity of the pain gave no indication as to the degree of hydronephrosis or renal destruction.

Hematuria. While this is a relatively common sign and a very confusing one, it is believed to be a rather late symptom developing only after considerable kidney damage has taken place. It occurred in 25.5 per cent of our series.

Infection likewise is a late sequel depending upon the degree of renal stasis and destruction.

Early Roentgen Signs. We have for a long time tried to deduce from the pyelogram one thing which might give a clue to an early diagnosis of an aberrant blood vessel surrounding the ureteropelvic junction. It was found that pain in some form or other was responsible for the patient seeking the advice of a physician. However, in the very early cases little if any roentgen evidence could be found. During the past few years, we have felt that there is one early roentgen sign that is usually present even without demonstrable hydronephrosis, namely a "squaring off" of the under border of the kidney pelvis, similar in appearance to an inverted bag, to one end of which a string has been tied. A later sign is dilatation of the renal pelvis followed by hydronephrosis. When this has taken place, the pelvis has a tendency to sag over a fixed point, the ureteropelvic junction, and the "squaring off" picture becomes much more evident. Our experience seems to justify the feeling that this picture is entirely different from the dilatation produced by stones or obstructions lower down in the urinary tract.

In our more recent cases we have attempted to evaluate the degree of renal cortical function with prognosis in view, but this is not always possible owing to the variable size of the kidney. However, if the roentgenogram is of sufficient clarity to show the distance between the minor calyces and the capsule, we believe that it is possible to predict with reasonable accuracy the degree of renal function by the amount of cortex remaining, which has checked with various other renal tests.

Before the use of intravenous urography, these cases were first seen by the urologist, but with the introduction of this method, so easily adaptable to private office practice of the roentgenologist, many cases, referred for non-radiating intermittent pain in the back, in which neither calculi nor positive spinal changes were demonstrable, have been found to be harboring an early hydronephrosis due to obstructions at the ureteropelvic junction from aberrant blood vessels.

The recognition of this condition may prevent unnecessary destruction of the kidney and, in this way, ranks as a notable advance in the progress of roentgenology.

Age Incidence. There seems to be no rule or order for the detection of this condition. In our series the oldest patient was sixty-three, the youngest five, and the average thirty-four years. Over forty years there were 17 cases; under forty years there were 30 cases; under ten years there were five cases.

Since the use of the surgical relief of hydronephrosis due to aberrant blood vessels, considerable diversity of opinion has arisen as to the proper method of approach. It might be of interest to briefly recall the

anatomical origin of these anomalous vessels. Those on the right side arise from the aorta and vena cava while on the left side they may arise from the renal vessels, aorta and vena cava, but also the spermatic vessels. It is probable, in the ascent of the kidney out of the pelvis in embryo and the subsequent rotation anteriorly of the kidney, that the spermatic artery and vein become compressed against the ureter at the pelvic junction, which explains the ante-ureteral position of the aberrant vessel, as shown by Hinman.

The lack of collateral circulation to the kidney is a basis for the doubts which exist as to the advisability of section of the obstructing vessel.

Operative Relief. Operative relief may be divided into 4 types: (1) Nephrectomy when the kidney is completely destroyed or when infection is present with involvement of the cortex. (2) Division of the vessels may be carried out when compression of the vessels fails to show considerable inhibition of the blood supply to the kidney cortex. This operation is indicated particularly when the pelvis is comparatively small and a plastic operation to shift the ureteropelvic junction away from the vessels is too difficult or impracticable. (3) Young's[28] plastic operation of resecting a large portion of the anterior and posterior surface of the pelvis in cases of large hydronephrosis in order to shift the ureteropelvic junction is a method of choice in this type of case. (4) A modification of the above operations by division of the vessels, resection of portion of the redundant pelvis and a wide plastic procedure at the ureteropelvic junction is usually indicated when stricture formation has taken place. In this operation a V-shaped incision is made in the pelvis extending down the ureter in the form of a Y. This incision is then closed like a V, thereby putting a wedge of pelvic tissue at the ureteropelvic junction with consequent widening of the orifice.

CONCLUSIONS

1. It is evident from the above figures that aberrant vessels involving the ureteropelvic junction are a common clinical entity.

2. Non-radiating pain is almost a constant symptom and in the absence of calculi and spinal changes aberrant vessels should be carefully excluded.

3. Early operative relief is indicated in order to prevent complete destruction of the kidney.

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ROENTGEN STUDIES OF THE SHOULDER

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CHRONIC shoulder disability, especially disability following injury to the tendons, is one of the conditions which is a source of much concern to industrial accident boards and insurance companies. From the economic standpoint, these cases of disabled shoulder are very important. The financial loss to the insurance companies is great and the permanent loss in the earning power of the patient is still greater. Earlier and more accurate diagnoses are necessary if these losses are to be reduced. Ordinary roentgen examinations have not been very helpful in the past, for a high percentage of these cases are reported as "negative." The purpose of this paper is to describe a roentgen technique which we have been using for several months and which we are sure has helped us to cut down our percentage of "negative" reports.

Codman[2] in his book on the shoulder says that roentgenologists must learn to take pains to show each facet of muscle insertion in profile. He shows pictures of shoulders made at various angles showing the muscle insertions but he does not describe a definite roentgen technique for the routine systematic study of these facets.

Most roentgen examinations of the shoulder consist of one or two films made with the patient on his back and the arm in external rotation or in partial internal rotation with the forearm across the front of the body. If the arm is fixed by a dressing or if it is too painful to be moved because of a recent injury, it may be impossible to do anything more. We believe, however, that an attempt should be made to make a lateral view in all cases of fracture of the neck or upper end of the huerus even if this view has to be made through the body of the patient. It is in the cases without gross fracture and the cases of chronic shoulder disability that a more careful systematic study often gives information which is well worth the additional pains required to make films at the proper angles.

The study of a shoulder dissection shows that there are two groups of muscles controlling the motions of the upper arm. First, there is an outer group consisting of the deltoid, the pectoralis major, the latissimus dorsi, and the teres major. These are all inserted into the shaft of the humerus below the surgical neck. Second, there is the inner group of short rotators, the supraspinatus, infraspinatus, teres minor and subscapularis. This group is intimately associated with the capsule of the shoulder joint and forms a muscle cap over the front, top and back of the head of the humerus. The long head of the biceps runs over the top of the humerus and between the insertions of the subscapularis and supraspinatus, being partly covered by them. The space between the acromion and deltoid above and the short rotators below is lined with a sort of synovial membrane. This makes a very thin-walled sac capping the shoulder outside the short rotators. This is the so-called subacromial bursa described by Codman a number of years ago. It varies in size in different individuals though it is roughly about 2 inches in diameter.

A closer study of the lateral aspect of the greater tuberosity of the humerus shows that the anterior third of the top of the tuberosity slopes slightly forward. The posterior two-thirds of the top of the tuberosity slopes backward, forming an angle of about 25° with a horizontal line drawn at the top of the tuberosity. The supraspinatus muscle inserts on the top and anterior slope of the tuberosity. The infraspinatus inserts on the posterior slope of the tuberosity. The teres minor is in-

serted on the posterior edge of the greater tuberosity below the backward slope. The subscapularis is inserted on the front of the lesser tuberosity. The adjoining edges of the supraspinatus and infraspinatus tendons are fused together so that their insertions form a continuous line of muscle attachment on the bone. Small bits of bone are often torn from these insertions with injury to the tendons and can usually be seen and identified on films made at the correct angles.

After working with various angles, we have come to the conclusion that the four

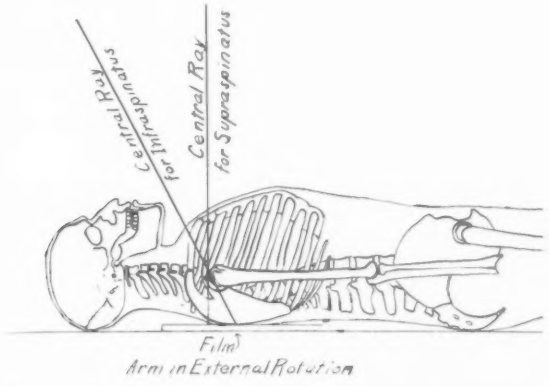


Fig. 1. First and second projections to show supraspinatus and infraspinatus insertions.

positions which we describe, with perhaps a fifth in special cases, can be used as a satisfactory routine examination; 8" by 10" films are used, so the expense is not greatly increased. Films made in these four positions will show the insertions of each of the short rotators in profile; they will show the relations of the humerus, glenoid, coracoid process and acromioclavicular joint in both anteroposterior and vertical planes and they will show calcifications in the tendons or free in the bursa.

The first position is the usual anteroposterior projection with the patient lying flat on his back and the arm in external rotation. The film is beneath the shoulder and the central ray is directed through the shoulder perpendicular to the film. This shows the shoulder joint, the acromioclavicular joint and the insertion of the

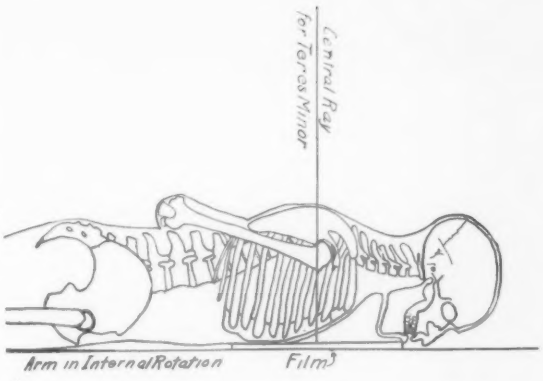


Fig. 2. Third projection to show insertion of teres minor.

supraspinatus which is seen in profile on the top of the greater tuberosity of the humerus.

The second position is similar to the first except that the central ray enters the shoulder from above at an angle of about 25° with the perpendicular. Thus the central ray is parallel with the backward slope of the posterior part of the tuberosity where the infraspinatus tendon is inserted. This angle may be obtained in one of two ways. The tube may be moved toward the head and then tilted toward the feet or the

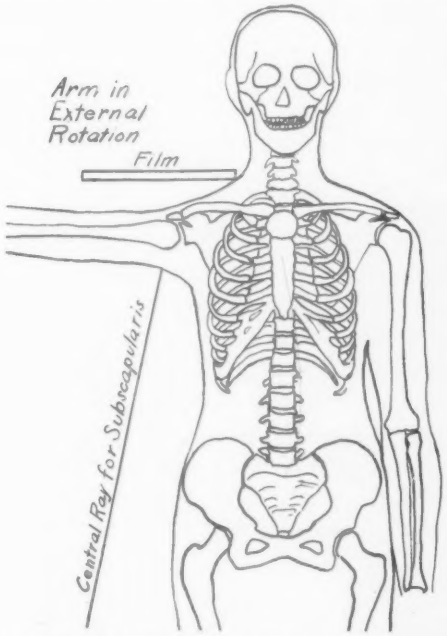


Fig. 3. Fourth projection to show subscapularis insertion on anterior edge of humerus.

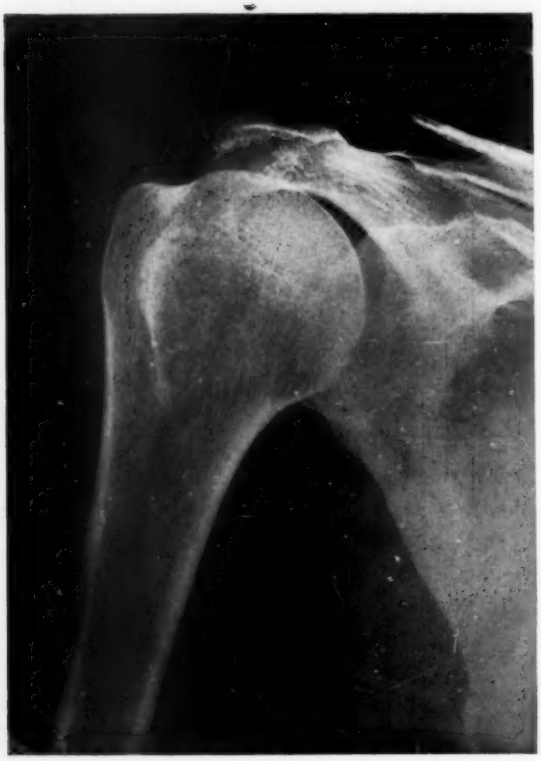


FIG. 4. Normal shoulder in first projection, supraspinatus insertion in profile on top of tuberosity.

tube may be kept level with the floor and the head of the table raised to the required angle, as is the common practice in making films of the sinuses. We use this latter method because our table has a hinged head piece which may be lifted to any desired angle. This position, which is similar to that described by Carnett,[1] opens up the space between the acromion and the head of the humerus. It shows the insertion of the infraspinatus in profile on the posterior slope of the tuberosity and it reveals calcifications in its tendon which may have been hidden in the first position.

The third position shows the insertion of the teres minor. The patient lies on his face, the arm is in extreme internal rotation with the hand behind the back if possible. The central ray is directed slightly outward at the point of the shoulder. The insertion of the teres minor is seen on the outer edge of the bone just distal to the joint surface.

The fourth position, which is one of great importance, is a vertical view. The patient lies on his back with the arm abducted to a right angle and in external rotation. The film is above the shoulder and the central ray passes up through the axilla. The insertion of the subscapularis is seen on the anterior edge of the humerus and the insertion of the teres minor is shown on the posterior edge. The glenoid and coracoid are clearly seen and the acromioclavicular joint may be outlined through the head of the humerus.

A fifth position may occasionally be useful as a check on the subscapularis. The patient is on his back with the arm abducted to a right angle and in internal rotation with the palm down. The film is beneath the shoulder and the central ray is directed through the shoulder perpendicular to the film. The insertion of the subscapularis shows in profile on the lower edge of the bone. In the fourth position,

FIG. 5. Normal shoulder in second projection; infraspinatus insertion in profile on top of tuberosity.

with the arm in external rotation, the tendon of the subscapularis runs across in front of the neck of the humerus so that calcifications in its tendon may sometimes be hidden by the bone. This fifth position shows the course of the subscapularis tendon across the axilla and may bring such calcifications into profile.

None of these positions are really new and probably many roentgenologists have used them on occasion, but we have never seen the combination used as a routine procedure, especially for the purpose of systematically studying the insertions of the short rotators.

The pathological changes seen on these films may be divided into four groups.

1. Fragments torn from the tendon insertions.
2. Changes in the tuberosity of the humerus itself secondary to ruptures and tears of the tendons.
3. Periosteal proliferations at the tendon insertions.

Fig. 6. Normal shoulder in third projection; teres minor insertion in profile on outer edge of humerus

Fig. 7. Normal shoulder in fourth projection; subscapularis insertion in profile on anterior face of lesser tuberosity.

4. Calcifications in the tendons.

Codman and Akerson[3] have shown from a study of pathological material that complete and partial tears of the short rotators are very common. With ruptures of these tendons, small flakes or spicules of bone are often torn from their insertions and there is usually injury to the periosteum. The flakes or spicules can usually be seen and the insertions from which they are torn can often be identified. The injury to the periosteum is probably the cause of the secondary changes which later occur in the humerus itself.

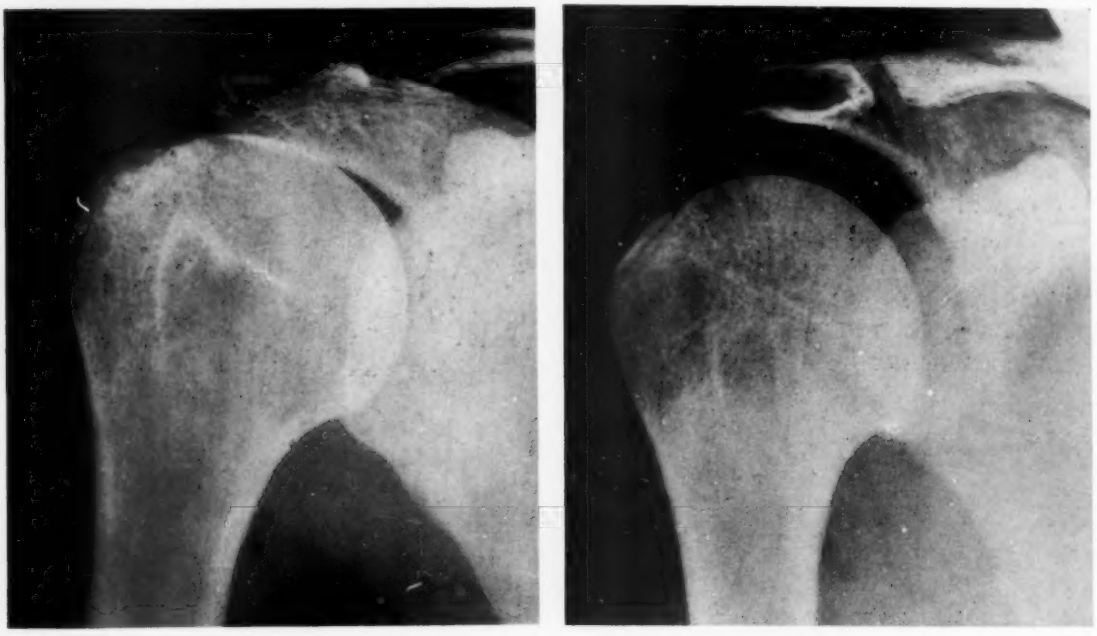
When a fragment is torn from the humerus it is usually near the insertion from which it is loosened and the defect in the bone at this insertion can often be seen. Spicules from a fresh injury are sharp, jagged and irregular, though they may later become smooth. These fragments must be differentiated from calcifications

in the tendons. These calcifications are usually smooth, rounded and of an amorphous appearance, with no break in the contour of the humerus.

The secondary changes in the tuberosity and head of the humerus itself have been well described by Henry.[4] They follow closely the pathological changes described by Codman and Akerson from their study of autopsy material.

gap in the muscle is large and the joint surface comes in contact with the acromion.

New bone proliferations at the tendon insertions may be the result of injury to the tendons or of low grade, chronic irritation over a long period. These proliferations may consist only in eburnation of bone at the tendon insertion or they may be seen as thick, rough exostoses. A line of dense bone along the top of the greater tuberosity



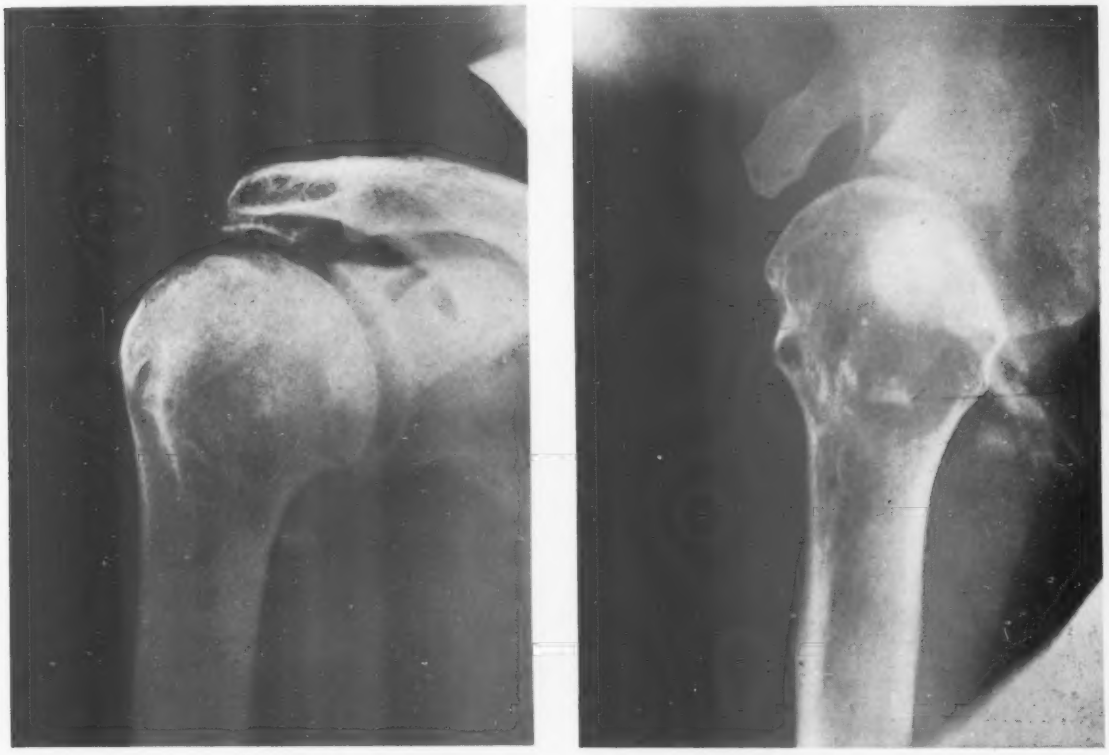
a *b*

FIG. 8. Fragment loosened from infraspinatus insertion; *a*, first projection; *b*, second projection.

Some time after a tendon rupture, small excrescences appear on the top of its insertion. Later areas of lime absorption occur, producing small cysts or "caverns," as Codman calls them, just at the bases of the excresences. Cyst-like areas develop lower down in the bone and there may be changes in the bony trabeculae. There is a smoothing and rounding of the bone with a loss of the prominence of the tuberosity. The sulcus between the tuberosity and the joint surface becomes filled with new bone and disappears. Erosion and destruction of the cartilage on the outer part of the head of the humerus takes place when the

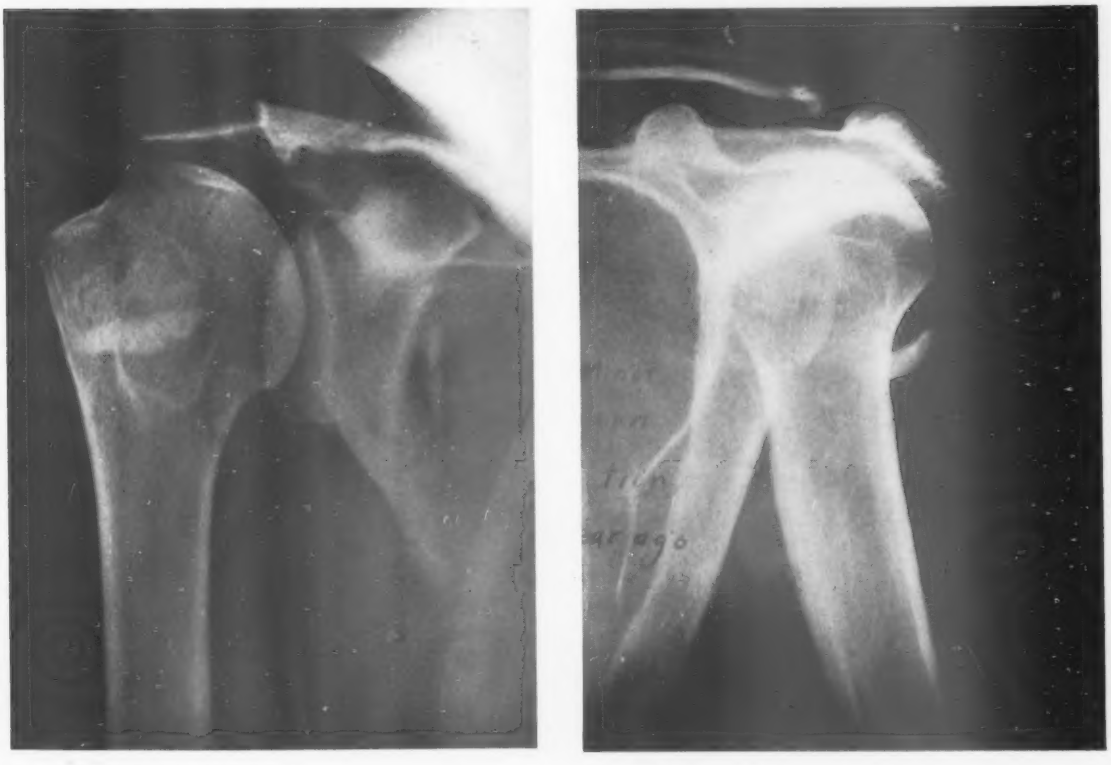
just beneath the attachment of the supraspinatus is quite common in laboring men; large heavy exostoses, though less common, are frequently seen. We have seen them at the insertions of the supraspinatus, the subscapularis and the teres minor.

Calcifications in the tendons are the most common lesions found. These were formerly called calcifications in the bursa, though Codman and many others have shown that they are rarely found in the bursa but ordinarily develop in the tendons beneath the bursa. They may occur in any of the tendons and they may be present in



a *b*

Fig. 9. Fragment loosened from subscapularis insertion; *a*, first projection; *b*, fourth projection.



a *b*

Fig. 10. Fragment loosened from teres minor insertion; *a*, first projection; *b*, third projection.

FIG. 11. Old injury to supraspinatus, fragments torn from insertion, excrescence on top of insertion, small "cavern" in outer part of tuberosity.

several tendons at the same time. They are often found in both shoulders and they may occur at the elbow and about the greater trochanter of the femur. We wonder if a more careful study of the tendon insertions about the hip might not reveal more of them and explain many cases of obscure hip pain.

Because of their location in the tendons it is quite common to have a calcification show in one projection and have it hidden in another. A small calcification seen just above the tuberosity in the first position but hidden in the second is undoubtedly in the supraspinatus. One seen in the second but obscured by the bone in the first is in the infraspinatus. A large calcification or one near the point where the supraspinatus and infraspinatus tendons fuse might be seen in both projections. Calcifications in the subscapularis may sometimes be seen through the bone in the first and second positions but show in profile in the fourth or fifth.

CONCLUSIONS

We have attempted to describe a technique for the roentgen study of the shoulder. This technique is applicable both in cases of chronic shoulder disability and in recent injuries when there is no gross fracture. It consists of four or occasionally five positions which give both anteroposterior and vertical views of the shoulder joint and show the insertions of each of the short rotators in profile. Its use has enabled us to discover and identify small fragments torn from the tendon insertions, calcifications in the tendons and changes in the bone itself secondary to injury to the tendons.

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Vol. 37, No. 6

POSTERIOR SUBACROMIAL DISLOCATION OF THE HEAD OF THE HUMERUS

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POSTERIOR subacromial dislocation of the humerus is a rare type of dislocation which presents several interesting and unusual features. Particularly is this true in regard to the manner in which the dislocation may be acquired, the difficulties which may be encountered in roentgenographic diagnosis, and the anatomical changes which may take place in the event that the dislocation is not reduced. In this article we wish to call attention to these features as noted in a series of 7 cases which we have examined, and compare our observations with those which have been reported previously in the literature.

CASE REPORTS

CASE I. G. W., male, was referred to us for examination on May 12, 1915. He had been employed as a lineman, and, while working at the top of a pole, came in contact with a high tension wire and fell to the ground. Immediately upon arising he noted that he could not use his left arm. He visited several physicians and had roentgen examinations made at two hospitals. Apparently nothing abnormal was found as a result of these examinations, since no treatment was advised. Our examination, consisting of stereoscopic anteroposterior and vertical views, showed a posterior dislocation of the humerus on the glenoid, the head riding astraddle the posterior lip of the glenoid. Following our report the patient was placed under complete anesthesia, the adhesions were broken down, and the dislocation was reduced. When the patient came out of the anesthesia he had almost complete use of his arm, although there was some limitation of motion due to contraction of the muscles about the shoulder girdle. Subsequently normal and complete motion returned.

CASE II. A. G., male, was referred to us for examination of the left shoulder on June 14, 1927. He gave a history of having fallen while playing tennis. Our examination (Fig. 1) showed a posterior subacromial displacement of the humerus with a fracture involving the anterior aspect of the head. This dislocation was reduced and a perfect functional result was obtained.

FIG. 1. Case II. Anteroposterior roentgenogram, left shoulder. Posterior subacromial dislocation of the head of the humerus with a fragment broken off from the anterior aspect of the head of the humerus.

CASE III. G. C., male, was referred to us on July 6, 1928. He gave a history of having injured his left shoulder during an epileptic seizure seven months prior to our examination. This was the patient's first seizure and it occurred while he was standing. We wish to emphasize particularly that he did not fall but was laid upon a couch by those present. He was taken to a hospital and stereoscopic roentgenograms of the left shoulder were made. The report of the examination was a fracture of the humerus at the junction of the anatomical and surgical necks, and a fragment broken off of the anteromedial aspect of the head. Subsequently two more sets of stereoscopic roentgenograms covering the left shoulder were made. At no time was there a diagnosis of dislocation.

At the time of our first examination six months after the injury, the patient was still complaining of some disability in his shoulder.

Fig. 2. Case iv. Right shoulder. *A*. Anteroposterior view. Dislocation cannot be seen. *B*. Vertical view showing posterior dislocation of head of the humerus, the new glenoid fossa on posterior aspect of the scapula, and the absorption of the anterior surface of the humerus.

This examination showed that in addition to the fractures previously reported, which by this time had united in good position, there was also a posterior subacromial dislocation of the humerus, the head being displaced just over the edge of the glenoid. There was some absorption of the head where it was in contact with the posterior edge of the glenoid. On the posterior aspect of the neck of the scapula, a mass of new bone had formed; and on the surface of this new bone, facing the head of the humerus, a new joint surface had developed.

This dislocation was never reduced. In spite of this, the patient gradually regained use of the arm so that eventually he was able to move his arm throughout almost the normal range of motion with practically no discomfort.

Case iv. J. S., female, was examined by us at St. John's Hospital on May 15, 1933. She gave a history of having had an epileptic seizure seven months prior to this date. This was her second attack, the other having occurred several years before. Immediately following her last attack she had severe pain in her right shoulder and limitation of motion. A roentgen examination was made and the patient was told there was nothing seriously wrong with her shoulder. The arm was kept in a sling for

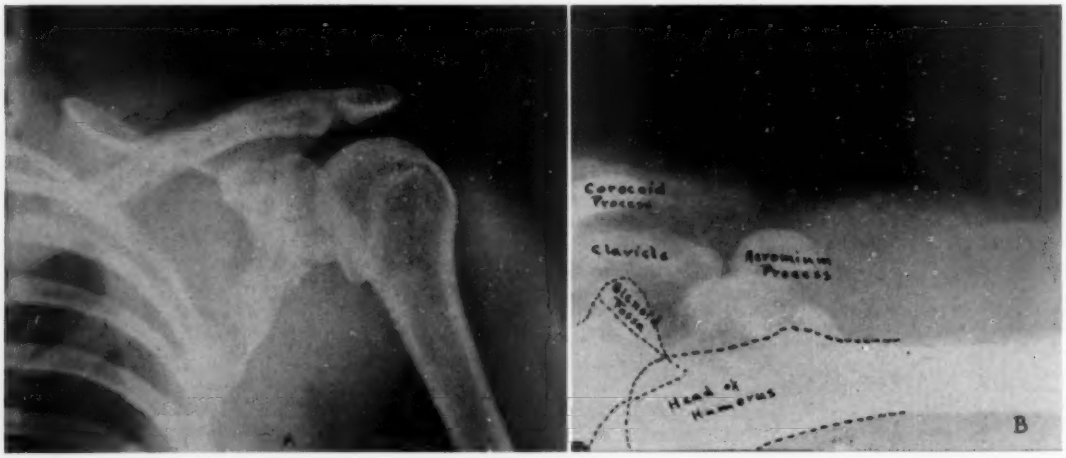

Fig. 3. Case v. Right shoulder. *A*. Anteroposterior view shows the presence of a fracture but the dislocation cannot be seen. *B*. Vertical view (glenoid fossa and anterior aspect of humerus retouched) shows a posterior subacromial dislocation.

about a month. At the end of this time she still complained of pain and limitation of motion. She consulted another physician who told her that the arm was dislocated. An anesthetic was given and the shoulder was manipulated. Apparently the dislocation was reduced, since the patient was considerably improved. However, some time later, when the doctor was manipulating the arm, the dislocation recurred. At this time, i.e., seven months after the original injury, she was referred to us for examination. We made stereoscopic anteroposterior and vertical views (Fig. 2). These roentgenograms showed that the head of the humerus was dislocated posteriorly, the anterior edge of the articulating surface of the humerus resting against the posterior edge of the glenoid. There was some absorption of the humerus at this point. On the posterior surface of the neck of the scapula, a fairly large mass of new bone had been laid down, and on the surface of this bone a new glenoid fossa was formed. The head of the humerus rested against the new joint surface.

Following our examination the shoulder was again manipulated under anesthesia, the adhesions were broken up and the arm dressed on an aeroplane splint. The dislocation, however, was not reduced. Following this treatment, there was considerable improvement but some limitation of motion and pain on forced movement still remained.

Case v. D. H., female, was examined by us at Huron Road Hospital on June 22, 1933. She gave a history of having had an epileptic seizure on this date while lying in bed. She did not fall out of bed, nor did she suffer any violence other than that due to muscular contraction during the seizure. Upon regaining consciousness, she experienced pain in the right shoulder region, with limitation of motion. Roentgen examination (Fig. 3), consisting of stereoscopic anteroposterior and vertical views, showed two rather large fragments of bone broken off from the head of the humerus in the region of the lesser and greater tuberosities, and a posterior subacromial dislocation of the head of the humerus. The shoulder was manipulated under general anesthesia. A roentgen examination

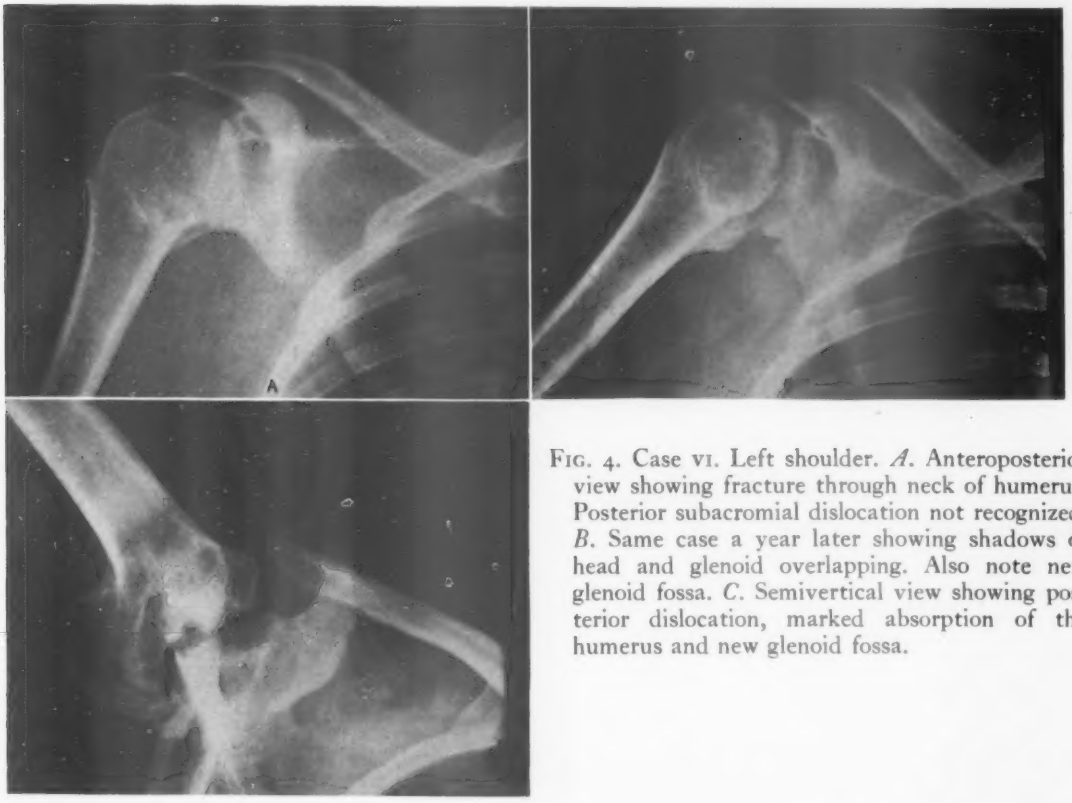

Fig. 4. Case vi. Left shoulder. *A*. Anteroposterior view showing fracture through neck of humerus. Posterior subacromial dislocation not recognized. *B*. Same case a year later showing shadows of head and glenoid overlapping. Also note new glenoid fossa. *C*. Semivertical view showing posterior dislocation, marked absorption of the humerus and new glenoid fossa.

following this showed that the dislocation was reduced and the fragments were in good position.

CASE VI. W. C. C., male, was referred to us on September 13, 1933. He gave a history of having had an epileptic seizure while lying in bed. He did not fall out of bed, nor did he suffer any violence other than that which could be attributed entirely to muscular contraction. This was his first attack. Upon regaining consciousness, he experienced pain and limitation of motion in the left shoulder region. Our examination (Fig. 4), consisting of stereoscopic anteroposterior views, showed a fracture of the humerus at the junction of the surgical and anatomical necks. No vertical view was made because we did not believe that it would be advisable to elevate the arm, especially since the fragments appeared to be in satisfactory position.

A month later the patient returned for another examination to determine the position of the fragments and the amount of callus. At this time another set of stereoscopic anteroposterior views was made. Much to our surprise we found that, in addition to the fracture, there was also a posterior dislocation of the humerus. We again reviewed the original films to find why such an error had been made, and found that it was only with the most careful scrutiny that the dislocation could be recognized. In fact, it was only when the films had been reversed in the viewing box, so as to examine the shoulder from the rear, that we could feel sure that there was a dislocation present.

The dislocation could be reduced under anesthesia, but it would immediately recur. At the present time the dislocation still persists.

Roentgenograms made a year later show the same anatomical changes noted in Cases III and IV, namely, new bone deposit on the posterior surface of the scapula with the formation of a new glenoid fossa, and bone absorption along the anterior aspect of the head and neck of the humerus. The functional recovery has been excellent and the patient states that he has almost complete use of the arm.

CASE VII. S. J., female, was examined by us at Huron Road Hospital on July 5, 1935. She stated that seven months previously her right arm had been wrenched by a purse-snatcher. She was examined by a physician and was treated for a sprained shoulder. No roentgen examination was made at that time. When she was referred to us she was still complaining of pain on motion, inability to raise her arm above the level of the shoulder, and considerable limitation of outward rotation of the arm. Our examination (Fig. 5), consisting of stereoscopic anteroposterior and vertical views, showed a posterior subacromial dislocation of the humerus with the anterior surface of the neck of the humerus resting against the posterior edge of the glenoid. There was also a mass of new bone on the posterior aspect of the neck of the scapula, upon which a new joint surface had

FIG. 5. Case VII. Right shoulder. *A*. Anteroposterior view. Dislocation cannot be seen. *B*. Vertical view showing posterior subacromial dislocation of the head of the humerus, absorption along the anterior aspect of the head and new glenoid fossa (retouched).

formed. There was also absorption of the neck of the humerus where it impinged against the glenoid. The dislocation has recently been reduced.

DISCUSSION

The infrequency of posterior subacromial dislocation of the shoulder may be judged from the fact that we have encountered only 4 cases in a series of over 6,000 shoulder examinations which we have made in our private practice. The 3 additional cases which we have reported were seen by us in hospitals with which we have been associated.

In 4 of the cases there were fractures as well as dislocations. In each of these cases the fractures involved the tuberosities, and in 2 of these there were, in addition, fractures of the shafts just distal to the tuberosities. This complication is worthy of particular emphasis, because there might be a tendency on the part of the examining physician to explain the symptoms and physical findings on the basis of fracture and, therefore, overlook the dislocation.

In 4 cases the injuries occurred during epileptic seizures, 3 during the patient's first attack and the other during the patient's second attack. In 3 of these cases there were fractures as well as dislocation, and according to the history obtained, the injuries must have been due entirely to muscular spasm, since in 2 cases the patients had their seizures while lying in bed, and in the third case the patient did not fall but was laid upon a couch by those present.

It may seem odd that even stereoscopic examination of the shoulder failed to reveal the dislocation in several cases. However, our experience in Case VI made us appreciate that, unless stereoscopic roentgenograms are scrutinized with extreme care, keeping in mind the possibility of subacromial dislocation, an error can easily be made. The difficulty in recognizing the dislocation is due apparently to the fact that the arm is generally rotated markedly inward so that the head of the humerus is pointing backward and the shadows of the head and tuberosities are more or less superimposed. As a result of this it is difficult to visualize the exact relationship of the head and glenoid. In Case VII we made one set of stereoscopic roentgenograms with the arm held in the position most comfortable to the patient, i.e., in inward rotation, and we found that we could not be positive as to whether or not there was a dislocation. A second set of stereoscopic roentgenograms made with the arm rotated outward as far as possible left no doubt as to the diagnosis. We have noted that reversing the films in the stereoscope so as to view the shoulder from the rear often gives a better stereoscopic effect and shows the dislocation more distinctly. The most important view is the one made with the arm extended, the film placed above the shoulder and the central ray directed cephalad through the axilla. Unfortunately this view cannot be made where there is an associated fracture in satisfactory position, since moving the arm to obtain such a view might displace the fragments. A lateral view through the chest is useful in certain instances. Examination of a single anteroposterior film, however, might be absolutely worthless, since in that projection the various structures might appear to be in normal relationship to each other.

The anatomical changes which took place in 4 cases in which the dislocations were not reduced are of interest. In each of these, new bone was deposited on the posterior aspect of the scapula opposite the head of the humerus. On the surface of this new bone, facing the articulating surface of the humerus, a new glenoid fossa was formed. In each of the cases there was absorption of the head in the region where it impinged against the posterior edge of the glenoid. This, no doubt, permitted a greater degree of mobility of the arm.

The functional recovery in those cases in which the dislocations were not reduced was very good. In 2 cases there was only slight limitation of motion and no discomfort, and in another case the patient complained of pain only when the arm was moved beyond the average range of motion.

REVIEW OF LITERATURE

Malgaigne,[1] in 1855, described "luxation sous-acromiale," and reported 37 cases, 3 from his own practice, and 34 from the literature and from members of the medical profession of his day. The first observation reported, according to Malgaigne, was in 1804.

Of these cases 5 were women. In 8 cases, definite histories of dislocation from muscular convulsion were obtained, 7 during epileptic seizures and 1 from convulsions limited to the shoulder. In none of these cases were there associated fractures, but this, from our experience, could not have been true, and, no doubt, a roentgenological examination would have disclosed associated fractures in the majority of his cases.

One of the cases reported by Malgaigne was a patient of Sir Ashley Cooper, this case having been recorded in *Guy's Hospital Reports* for 1839. The dislocation was produced by muscular violence during an attack of epilepsy. The following is Sir Ashley Cooper's comment on the case:

> Mr. Complin was 52 years of age and had been the subject of epileptic fits. One of these, which was particularly severe, occurred one morning whilst he was in bed, and in his violent convulsive strugglings his shoulder became dislocated. Mrs. Complin, who was with him, is confident that he neither fell from his bed nor struck his shoulder during the fit; and that the appearances which I have described and which remained until his death, were the result of muscular efforts alone, was the firm belief of Dr. Cobb, Mr. Key and myself.

In 1902, Mynter[2] reports a case of posterior subacromial dislocation from epilepsy. He did not see the patient until three months after the dislocation occurred. He also reports that many years previously he had seen a case of double subacromial dislocation as the result of muscular contraction from an overdose of camphor.

Moullin and Keith,[3] in 1904, report a case of backward dislocation of the humerus caused by muscular action. This occurred from a backhand stroke in tennis.

Dardel,[4] in 1930, reports that during his services as assistant to Kocher he saw 2 cases of posterior dislocation of the head of the humerus, and later in the service of Professor DeQuervain 2 more cases. One of these cases produced during epileptic seizure was not recognized for one year. He states that Professor Ellerbrolk, in a review of 404 dislocations of the shoulder, saw 400 anterior dislocations and 4 posterior. He does not state, however, whether the latter were subacromial or subspinous.

Caraven,[5] in 1931, reports a case of posterior subacromial dislocation as a result of a fall from a motorcycle.

Coover,[6] in 1932, reports a case of double posterior subacromial dislocation as the result of epileptic seizure while the patient was lying in bed.

CONCLUSIONS

We have presented 7 cases of posterior subacromial dislocation of the humerus and have emphasized the following points:

1. Posterior subacromial dislocation of the humerus is a comparatively rare type of dislocation.
2. It is frequently complicated by fractures about the head and neck of the humerus.
3. Both dislocations and fractures may occur during epileptic or other convulsive seizures and are due entirely to muscular spasm.
4. A large percentage of the cases are not recognized until months after the injury.
5. In the event that the dislocation is not reduced, a new glenoid fossa may form on the posterior aspect of the scapula, and absorption of the head and neck of the humerus opposite the posterior edge of the glenoid may take place.
6. In these cases a surprisingly good functional recovery has been noted.

To this discussion we should like to add a word of warning, namely, that the possibility of a posterior subacromial dislocation of the humerus should always be

kept in mind when examining a shoulder joint. The history of the injury may be misleading, the finding of an obvious fracture may beguile one into concluding that no other injury is present; and a perfunctory study of the stereoscopic roentgenograms may not reveal the presence of a dislocation. However, if particular care is taken in the study of the roentgenograms, keeping in mind the above possibility, we believe that the percentage of errors in the diagnosis of posterior subacromial dislocation of the head of the humerus will be greatly diminished.

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OSTEOPATHIA CONDENSANS DISSEMINATA

"SPOTTED BONES"

With Report of a Case

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SEVERAL articles have appeared in the literature in recent years dealing with a condition variously designated osteopecilia, osteopoikilosis, osteitis condensans generalisata, osteosclerosis fragilis generalisata and osteopathia condensans disseminata. As each author is describing what is obviously the same clinical entity, it is to be regretted that the nomenclature is in such a confused state. The terms osteopecilia (Fr. *poecilie*) and osteopoikilosis (Gr. ποικίλος) are terms presumably used because they describe the spotted or mottled appearance of the bones as seen in the roentgenogram and are not, therefore, founded on a scientific basis and should be rejected; the term osteosclerosis fragilis generalisata is based on an alleged property of the diseased bones, and does not rest on either an anatomical or pathological basis and should also be rejected; while the term osteitis condensans generalisata is inaccurate in that it implies an inflammation of the bone, whereas no actual inflammation exists.[37] Thus we have left only the term osteopathia condensans disseminata, which suggests a pathologic condition comprising a dissemination of areas of condensed bone elements. This constitutes an accurate definition founded upon an anatomico-pathologic basis, and at the same time furnishes an adequate description of the condition and is, therefore, the most desirable of the terms suggested.

We have been able to find in the literature only 45 cases reported, and while by far the greater majority has emanated from European observers, there is no reason to believe that the disease is more prevalent there than in any other part of the world, or that either climate or race may have any influence on the incidence. The condition is observed about twice as frequently in males as in females. Heilbron, while discussing a paper by Steenhuis, stated that he had observed the condition in a fetus of four months,[39] and Keyser stated in the same discussion that he had observed it in a child only a few days old. While Heilbron's observation has not been confirmed, and its accuracy may be questioned by some, it is certain that the condition may occur at a very early age, and the statement has been made by several observers that it is a hereditary and congenital condition.

As the disease is without symptoms clinically, and as all primary cases so far reported have been found accidentally, it is not known definitely as yet at what age it begins or whether it is, in fact, congenital, and possibly hereditary.

While Albers-Schönberg[1] is generally credited with having reported the first case, Bloom[5] quotes König as stating that the disease reported by Albers-Schönberg in 1915 was an entirely different clinical entity, usually called "marble bone disease," in which there occurred "massive structureless areas of density combined with thickening of the cortical layer and narrowing of the bone marrow," these changes occurring in the diaphyses of bones as well as in the epiphyses and metaphyses, and nearly always associated with "a thickening of the sella turcica and posterior clinoid processes." This constitutes a picture totally different from that of osteopathia condensans disseminata.

What was apparently the first authentic report of the condition under consideration was that by Stieda,[40] in 1905, who is

quoted by Bloom[5] as having reported "cases of circumscribed condensing of the bone in the region of the substantia spongiosa, based on roentgen examination of macerated bone and anatomical specimens." He stated that he found such changes in 18 to 20 per cent of eleven roentgenograms of the calcaneus, 2 instances in six plates of the head of the humerus and 2 in six plates of the scapula. He also studied these changes microscopically and found that the bone nuclei were "composed of compact islands of corpuscles and lamellae in irregular arrangement, while the surrounding bone shows the Haversian canals and lamellae to be well defined."

Subsequent to Stieda's observations, cases were reported by the following: Ledoux-Lebard, Chabaneix and Dessane, 1 in 1913; Laurent-Mouteau (quoted by the above authors), 1 in 1916; Moreau, 1 in 1916; Richarz, 1 in 1922; Schéle, 1 in 1922; Wachtel, 1 in 1921; Voorhoeve, 3 in 1924; Steenhuis, 1 in 1926; Bistolfi, 1 in 1927; Buschke and Ollendorff, 1 in 1928; Van Dorp-Buecker Andreae, 1 in 1928; Newcomet, 1 in 1929; Gluch, 1 in 1929; Amundsen, 1 in 1930; Guillain and Mollaret, 1 in 1930; Awalischwili, 1 in 1930; König, 1 in 1930; Reiser, 1 in 1931; Schmorl, 1 in 1931; Haack, 1 in 1931; Van Pée, 1 in 1931; Wilcox, 2 in 1931; Mascherpa, 1 in 1931; Schwartz and Nadaud, 1 in 1931; Windholz, 3 in 1932; Bloom, 1 in 1933; Brücke, 1 in 1933; Derome, 2 in 1933; Nichols and Shiflett, 1 in 1934; Erbsen, 1 in 1934; Fawcitt, 1 in 1934; van Staveren, 1 in 1935; Gandy, Guilbert and Crasneanschi, 1 in 1935. The following have also reported cases: D'Istria, 1 case in 1928; Lauterburg, 2 cases in 1928, and Svab, 3 cases in 1932, making a total of 45 cases.

The general appearance of the roentgenogram of a case of osteopathia condensans disseminata is very well described by the loose term "spotted bones." The lesions, composed as they are of areas of condensed bone, show as white splotches varying in size from 2 mm. to 1 cm. in diameter, and are thickly and indiscriminately scattered throughout the affected area, with no special group arrangement, often appearing to overlap or coalesce. Their shape is often perfectly spherical, but the greater number of the lesions are oval in shape, the long axis of the oval corresponding to the long axis of the bone when near the diaphysis in long bones, but running in the general direction of the principal trabeculae in the epiphyses and in the flat bones. The borders of the individual lesions do not appear as sharply defined edges (though Schmorl,[37] who performed the first reported autopsy of a case in 1931 is quoted as saying the surface, macroscopically, was "smooth and glistening"), but appear somewhat as a fleck of cotton lint of a similar size, i.e., with a slightly frayed or fuzzy outline.

The impression received on inspection of the roentgenogram is that the condensed areas are scattered throughout the entire thickness of the spongiosa, but this is not the case, as upon section of the bone they have been found only immediately under the superficial bony lamella, and it is this fact that causes the impression of coalescence of the areas, for the image of a near lesion may overlie in part the image of a lesion on the side of the bone farthest removed from the film.

The microscopic appearance of the individual lesion, as abstracted from Schmorl's report by Nichols and Shiflett,[30] is as follows:

> . . . the areas of increased density were formed by numerous juxtaposed trabeculae resembling those of the spongiosa more than of the cortex. This close arrangement gave the appearance of compact bone which was observed while studying the gross specimens. The merging of the trabeculae into the spongiosa was gradual and sharply defined borders were absent. The trabeculae were thin at times, at other times they formed tufts in which the thickness of the trabeculae varied. The thickened ones consisted of lamellous bone arranged mostly parallel to the long axis of the bone, but a few were obliquely arranged, while some were grouped chiefly in the periphery, concentrically around blood vessels, without a typical osteomatous formation.

The histologic study did not permit definite conclusions as to the genesis of the trabeculae. The author thought that they probably arose from the fibrous portion of the bone marrow. It was not possible to determine whether the areas of osteopoikilosis increased in size after they were once formed. Schmorl stated that this would have to be determined by repeated roentgen examinations at regular intervals. He did not consider an endochondral origin probable as the areas of increased density were not connected with the endochondral zone of growth and areas of cartilage were not observed in any of the numerous areas described above.

This report was also quoted as saying that "in the interior of the individual lesions the trabeculae formed an irregular dense mass where were found osteoblasts and osteoclasts" but "no trace of Haversian canals."

Rickets was not considered a probable etiologic factor. The conclusion was that "osteopoikilosis is probably a congenital anlage."

It is interesting to note at this point that Newcomet[29] noted no roentgenographic change in the lesions exhibited by his patient during four years' observation, and the case reported by Nichols and Shiflett showed no changes during a period of seven years.

In the light of the foregoing, it seems safe to conclude, therefore, that the condition is at least congenital, and that the lesions once formed show no change in size, contour or calcium content. This view is supported by Schmorl who stated there was sign of "neither resorption nor of production."

A few incomplete familial studies have been made, 1 by Voorhoeve,[47] who noted the condition in a father, son and daughter; 1 by Wilcox,[49] in which a father and son exhibited the lesions, but a daughter showed no evidence of the disease, and 1 by Svab[42] who reported cases in a father and two sons. The mother of the two sons was found to be without the lesions as was a daughter (2½ years old) of one of the sons. Awalischwili[3] did not find the condition in six brothers of his patient. Mascherpa[27] reported that a brother and sister of his patient showed "slight signs of the disease." In Bloom's case one sister exhibited an isolated lesion in the second metacarpal "which resembled the multiple foci found in the boy."

As Erbsen[13] in 1934 reported the presence of a lesion in the cranium, the condition has now been reported as observed in every bone in the skeleton with the exception of the spinal column and the ribs. They have been most frequently observed and in the greatest number roughly in the following order: pelvic bone, heads of femora, heads of humeri, metacarpals, phalanges and carpals, metatarsals, phalanges and tarsals, condyles of the femora, tuberosities of the tibiae, lower ends of the tibiae and fibulae, condyles of the humeri, upper ends of the radii and ulnae, scapulae, patellae, and least frequently, and in fewest numbers, in the clavicle (in which the lesions are usually seen at the acromial end); also Bloom noted a lesion in the mandible, Erbsen, as just mentioned, noted a lesion in the cranium recently, and our own case showed a lesion in a sesamoid bone.

Windholz, Wilcox, Svab and Voorhoeve all believed the condition hereditary, but Wilcox suggested the possibility of a parathyroid disturbance, while Svab thought a familial diabetes, present in his case, might have "aggravated the preexisting condition"; and Ledoux-Lebard, Chabaneix and Dessane thought typhoid fever might have been a factor in their case; Nichols and Shiflett also mentioned typhoid fever as having occurred in their patient, who suffered from hypopituitarism. Steenhuis[39] and Wachtel[48] both noted the presence of tuberculosis in their cases and suggested a possible causal relation. In 1 case reported by Pokorny and Pokorny,[33] in 3 reported by Windholz[51] and in 1 reported by Svab[41] a disseminated lenticular dermatofibrosis was noted. In 1934, Curth[10] also reported a case in which the two conditions were associated. Buschke and Ollendorff[7] likewise noted this association in their case and pointed out an analogy between the two. Schmorl's

case was the subject of osteomyelitis with metastases, and Bloom's[5] occurred in a congenital luetic. Guillain and Mollaret's case[17] occurred in an achondroplastic, while Windholz[51] recorded a slight deviation in the calcium and phosphorus metabolism in the blood of 2 cases. Voorhoeve's theory was that the condition belonged to the group of dyschondroplasia, stating that disseminated condensing osteopathy and dyschondroplasia were merely different manifestations or phases of the same process. Schmorl[37] stated that he found no evidence of inflammation or infection. Bacterial embolism has also been advanced as a possible cause, but without sufficient supporting evidence.

The most logical discussion of the etiology we have found in the literature is that of Nichols and Shiflett,[30] who state that:

> Since only bones formed in membrane have not been reported as involved, it would seem logical to infer that osteopoikilosis, in some way, is related to enchondral bone formation, and that it results from an abnormal functional relationship betweeen the osteoblastic and osteoclastic activity of cells during the growth period, but the histopathologic study made by Schmorl does not support this hypothesis. The influence of endochondral relationship also is supported by the fact that the diaphyses, metaphyses and epiphyses are involved, indicating that the process is associated with the growth period and continues until the epiphyses are united. This statement would of course be true only if the observations are correct that there are no progressive changes in the lesions. This can be established only after further observation and study of a larger series of cases, particularly during the growth period.

Köhler[21] quotes one author has having advanced the theory that the disease develops upon the basis of a rachitic osteomalacia, and adds, "Others dispute that interpretation and seek the cause of the disease in an abnormal calcium metabolism in intrauterine life, continued into post-natal life." And of all the guesses that have been made as to the etiology, the last seems to us nearest the truth.

The case here reported, like all others thus far recorded, unless in familial study, was found by accident. The patient was a merchant seaman who, while hauling on a line, was thrown heavily against a davit, and was referred to the roentgen department to rule out a possible fracture. When the film was developed no fracture was seen, but the multiple lesions of osteopathia condensans disseminata were revealed. The patient upon being informed as to the condition readily agreed to cooperate in a further study of the case, and roentgenograms of the entire skeleton were made.

REPORT OF CASE

The patient, D. C. K. (Reg. No. 25,578), was a white male, aged twenty-two, single, a native American, and of American parentage, who had led the life of the average boy, was living at home with his mother, brothers and sisters, and following the life of a merchant seaman.

Family History. The paternal grandfather was described as a very large man, tall, and weighing 260 pounds. He died suddenly at seventy-five years of age of heart disease. The paternal grandmother died of "natural causes" at ninety-three. The maternal grandfather, 6′6″ in height, died at about fifty-six years; cause of death not known. The maternal grandmother, who was only 4′9″ in height, died at eighty-six years, it was thought of heart disease. The father, who was about 6′ in height, died about three months prior to the patient's admission, of pneumonia. The mother is living at sixty years and is in good health except for some "female trouble," the character of which could not be learned. There are five living brothers and sisters as follows: the oldest, a sister, thirty-three years of age, married, in good health, has a daughter thirteen months old, also in good health; a sister, aged thirty, in good health, married, and now eight months pregnant; a brother thirty-one years old, and in good health until past year, suffering from a mild myocarditis of unknown etiology; a brother, aged twenty-seven, in vigorous health, and a sister, aged twenty-five, single and in good health.

The family history is negative for cancer, tuberculosis, insanity, epilepsy and diabetes.

Neither is there history of dwarfism, microcephalism, macrocephalism, excessive bowlegs, knock knees or rickets. The height of the members of the family has varied, however, from that of the maternal grandfather, who was 6′6″, down to that of the maternal grandmother, who was only 4′9″. The brothers and sisters are all of medium height, or more, and are all well formed, well developed and well nourished.

FIG. 1

The patient is 5′8½″ in stocking feet and weighs 159 pounds. He is unusually well proportioned, with a fair, smooth, properly moist skin, blue eyes, and a medium heavy suit of dark brown hair, normally heavy eyebrows, and a normal masculine voice. His carriage is erect, legs straight, all bony landmarks normal in position and size; He is well muscled, and there is no excess fat. The eyes and vision, the ears and hearing are normal. The throat is normal, and thyroid is not enlarged. There is no general adenopathy. The joints are all normal except the right elbow (vide infra); there is no dystrophy of hair, nails or teeth. The heart is normal in size; pulse rate 80, with regular rhythm; blood pressure 124/72; arteries are soft. The lungs are normal; the abdomen is flat and soft, and reveals no masses or tenderness on palpation; the inguinal rings are competent; the genitalia are those of a normal male, with normal amount and growth of pubic hair.

Personal History. Pneumonia at one, two and three years of age; measles at three years, and no other illness. The history is entirely negative for venereal disease of any kind. At the age of thirteen he fell from a horizontal bar at school sustaining a fracture of the right arm involving the elbow joint, which knitted in the normal time limit, but still shows a slight limitation of extension. During the same year, he had an accident while riding in which the horse fell upon him causing a fracture of the right ankle. He states he was on crutches for about three or four months. There is no other history of bone injury, and it will be noted that the nature of both these accidents was sufficient cause for the fractures that occurred, and that recovery was not unduly delayed. while the results were those that would be expected in any normal subject. The patient states he feels perfectly well and vigorous, and has always been perfectly well, except for the foregoing. The primary roentgenogram confirmed the findings of normal heart and lungs.

Urinalysis revealed an acid reaction in an amber colored urine of 1.015 sp. gr., negative for albumin and sugar, showing no blood, casts or mucus, and only an occasional epithelial and pus cell. Bence-Jones bodies were absent.

Blood examination showed 4,520,00 erythrocytes, 7,000 leukocytes, with 90 per cent hemoglobin. Small mononuclears 38 per cent, large mononuclears 1 per cent, transitionals 3 per cent and neutrophiles 58 per cent. The blood Kahn reaction was negative. The blood calcium was 10.9 gm. per 100 cc. of blood.

Additional roentgenograms were made systematically covering the entire skeleton, and all bones were found involved except the skull, spine and ribs. the areas of increased density measured from 2×3 mm. to 4×8 mm. They were both spherical and slightly oval in shape, and so numerous in the spongy portion of the pelvis that the shadows of the lesions overlapped. The dense bone of the shafts of the long bones showed only an occasional dense area. The bone surrounding these areas was quite normal in appearance. The greatest number of the areas was seen in the pelvic bones, adjoining the hip joints and the sacroiliac joints (Fig. 1). The wings of the ilia were almost entirely free of the dense areas, but the crests of the ilia showed many lesions. The femora showed numerous areas from the head of the bone to the lesser trochanter, with only two or

Fig. 2

Fig. 3

three of the areas in the shafts. All bones showed similar changes except, as stated above, the skull, spine and ribs. Only a very few changes were seen in the clavicles. A small sesamoid bone at the elbow joint showed a dense area almost as large as the bone itself (Fig. 2).

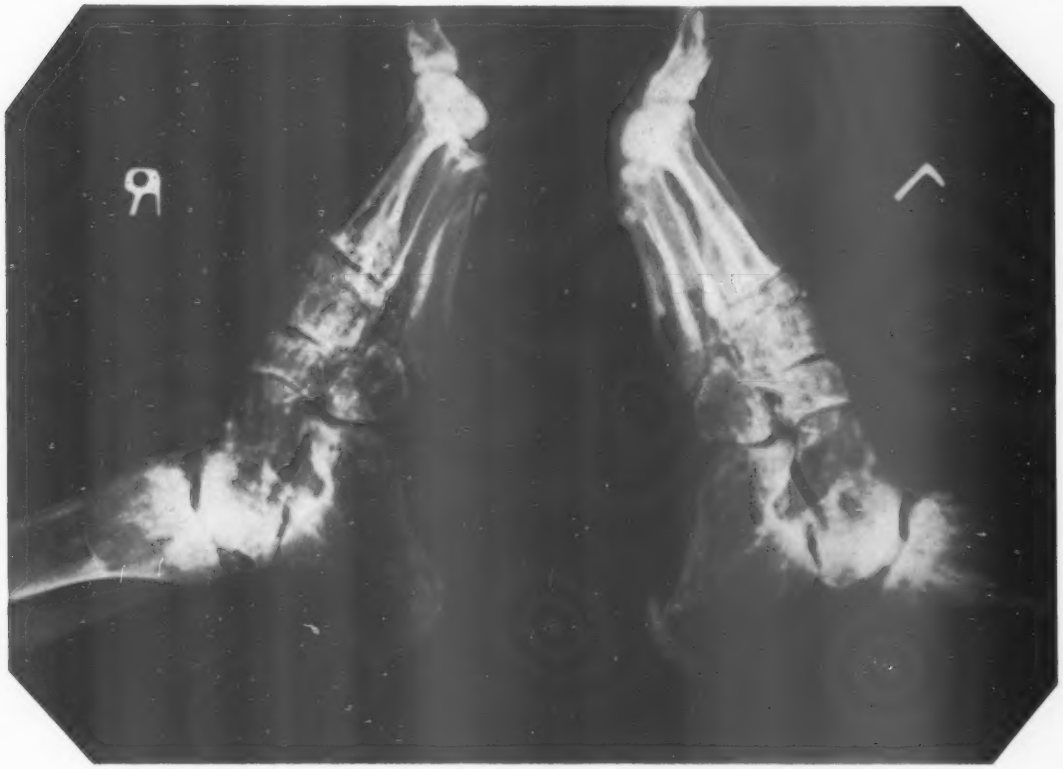

Fig. 4

The patellae contained more than a dozen such areas each (Fig. 3). No other evidence of bone pathology was seen in the skeleton.

The records of this hospital show that the twenty-seven year old brother was examined roentgenologically in November, 1933, the examination embracing views of the ribs, head of the right humerus, lumbar spine and pelvis, including the necks of the femora.

The records also show several roentgenograms of the brother, aged thirty-one, with views of the lower ribs, lumbar spine and pelvis, including the heads of the femora, the right knee and the right hand.

Subsequent to discovery of the fact that osteopathia condensans disseminata existed in the case here reported, a series of films were obtained of the mother, sixty years of age; of the oldest sister, thirty-three years of age, and of her thirteen months old daughter; of the married sister, thirty years old, who at the time of taking of the films was eight months pregnant. Care was taken to obtain excellent films of the eight months fetus, in the hope of being able to demonstrate the existence of the condition before birth, but none of the roentgenograms of any of the above cases showed the slightest evidence of bone pathology.

An effort was also made to secure the films of the patient made at the time of his fractures, sustained at the age of thirteen, but the hospital at which he was treated had destroyed all films made prior to 1929.

This case presents another possible (though not probable) etiologic factor, viz., consanguinity, as the father and mother of the patient were first cousins.

SUMMARY

1. A case of osteopathia condensans disseminata is reported, not because it differs materially from previously reported cases, but merely as confirmatory evidence in support of previous observations.

2. Attention is invited to the confused state of nomenclature, and a plea made for the adoption of the designation osteopathia condensans disseminata, which is founded on an anatomico-pathologic basis.

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NON-PARASITIC CYST OF THE SPLEEN*

WITH SPECIAL REFERENCE TO ROENTGENOLOGICAL AID IN DIAGNOSIS

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CYSTS of the spleen are uncommon and, when encountered, present diagnostic problems sufficiently difficult to justify the report of the following case, which places special emphasis on roentgenological findings. The roentgenological findings, as pointed out in our case, may be of invaluable aid in localizing cystic disease of the spleen.

REPORT OF CASE

The patient, D. K. a schoolgirl, white, aged thirteen, referred by Dr. Baylin, was admitted to the medical service of Sinai Hospital, March 27, 1935. The chief complaint was that she had "an abdominal mass found by her physician."

Family History. Both parents and one sister living and well. No history of familial or hereditary diseases.

Past History. General health good. Had scarlet fever, measles, mumps, chickenpox, and whooping cough prior to the age of five. No rheumatic fever or chorea. No previous injuries or operations. Review of systems entirely negative. Menses began at twelve and were always regular.

Present Illness. Six days previous to admission the patient had a mild attack of tonsillitis and a physician was called. On examination, a mass was noted in the left upper quadrant, and hospitalization was advised. There were no specific complaints referable to the abdominal mass except that about one month before admission she had experienced a dull, aching pain in the left upper quadrant which disappeared after a night's rest. There had been no gastrointestinal, cardiorespiratory or urinary symptoms.

Physical Examination. Temperature, 99.6° F.; pulse, 90; respirations, 24; blood pressure, 110/70. The patient was a well-developed, and well-nourished, moderately obese girl lying comfortably in bed. The mucous membranes were of good color. No cyanosis. The skin was of normal texture and showed no eruptions or petechiae. No general glandular enlargement. The pupils reacted to light and accommodation, and were regular and equal. Fundi negative. No scleral icterus. No bleeding of the gums. The pharynx was reddened and both tonsils were hypertrophied and injected. The thorax showed an obvious bulge of the lower left ribs anteriorly. The percussion note was resonant throughout, but the left diaphragm was higher than the right and did not descend well on inspiration. The breath sounds were vesicular throughout. The heart was not enlarged but seemed somewhat displaced upward, the apical impulse being seen and felt in the fourth interspace. At the apex there was a short palpable thrill, diastolic in time. The rhythm was regular. The sounds were of fairly good quality and intensity. There was a moderately rough blowing apical systolic murmur which was transmitted only a short distance towards the axilla, and a short low-pitched presystolic murmur just within the apical impulse. The contour of the abdomen was not symmetrical due to a definite bulge of the left upper quadrant which extended over towards the midline as far down as the umbilicus. On palpation there was a large firm mass occupying the left upper quadrant extending upward under the costal margin pushing up the lower ribs on the left side. The rounded edge of this mass was felt as far over as a few centimeters past the midline and down to the level of the umbilicus. The upper border, as noted by percussion, extended as high as the eighth rib in the mid-axillary line. The mass was quite firm, giving a slight sense of fluctuation, and was smooth over its entire contour, except at its lower pole where a single notch could be vaguely felt. There was no tenderness over any portion of the tumor. It moved only slightly with deepest inspiration. No masses, tenderness or spasm were present over other portions of the abdomen. The liver and kidneys could not be felt. Pelvic and rectal examinations were not done. The extremities were negative. No pathological reflexes.

Laboratory Data. Blood: Hemoglobin, 82 per cent (Sahli); red blood cells, 4,000,000; white

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blood cells, 7,000; differential—polymorphonuclears, 72 per cent; lymphocytes, 24 per cent; metamyelocytes, 4 per cent; platelets present in normal numbers. Urine: clear, straw colored, acid reaction; specific gravity, 1.012; albumin, 1 plus; sugar, acetone and bile negative; one leukocyte per high power field, no red blood cells, occasional hyaline cast. Stool, negative. Phenolsulphonphthalein, 40 per cent in two hours. Wassermann reaction, negative. Blood chemistry, normal. Tuberculin intradermal test (0.1 mg.), negative.

Course in the Hospital. Patient's findings remained the same and she was asymptomatic. On April 10, 1935, a splenectomy was performed by Dr. Alfred Ullman.

Operative Note. A huge spleen was seen containing about 2½ quarts of fluid under tension. Splenic tissue present at the hilum. The rest of the mass was made up of encapsulated fluid. It measured 22×12 cm. and displaced the stomach to the right and the left kidney downward to the level of the brim of the pelvis. The spleen itself filled the entire left upper quadrant from the dome of the diaphragm down to about 8 cm. below the level of the costal margin. No adhesions, only the normal splenic ligaments were present.

Recovery was uneventful and the patient was discharged from the hospital in good health on May 6, 1935. There were no cardiac murmurs or urinary changes on discharge.

Pathological Report. Gross Pathology: Specimen consists of a cystic mass of the spleen. It is already opened. It measures 23 cm. in diameter and 13 cm. in thickness. The cyst occupies the portion of the spleen which is above the notch and leaves intact enough splenic material to be equivalent to a normal spleen. The cystic portion is very thin walled and consists of some trabeculae arranged in honeycomb fashion flattened against the outer wall. It is serous lined. There is some dirty looking material present in some of the small clefts. Microscopic Pathology: Section 1 shows remains of spleen. There is very heavy polymorphonuclear exudation throughout. This portion is undoubtedly cyst wall. Section 2 is that of spleen showing bloody extravasation, marked edema and polymorphonuclear and leukocytic exudation. Section 3 is that of spleen showing in general a loss of splenic architecture. It is edematous. There is moderate bloody extravasation and leukocytic infiltration. Diagnosis: cyst of spleen, nonspecific; subacute recurrent splenitis.

DISCUSSION

Cysts of the spleen are divided usually into three general classes: (1) dermoid cysts—rare; (2) echinococcus cysts, and (3) non-parasitic cysts, of which our case is an example.

Non-parasitic cysts of the spleen occur rarely. Benton,[1] in reviewing the literature, collected a total of 96 cases up to 1932. Since that time 10 more have been reported in the literature. The condition is most frequent in females, about 65 per cent occurring in that sex, usually between the ages of twenty and fifty. However, cysts of the spleen have been reported in young children and even in infants.

Symptoms are vague, the tumor, perhaps, being the first thing noted by the patient. A sense of fullness or dragging sensation in the epigastrium may occur, and, although less frequent, pain in the left upper quadrant or left thorax may be noted. In some cases, as in the one reported, the mass may be felt first by a physician during a routine physical examination. Dyspnea, palpitation and gastrointestinal symptoms occur when the tumor has grown quite large.

The diagnosis depends chiefly upon physical examination and roentgenological evidence. The tumor is in the left upper quadrant, usually occupying the left epigastrium. Frequently, it extends to the right of the midline and down as far as the umbilicus. The splenic notch, if felt below the costal margin, may be of distinct aid in localizing the spleen as the site of the tumor. In some cases actual deformity of the chest wall on the left may be seen in addition to the fullness in the left upper quadrant of the abdomen. Fluctuation in the mass when felt gives a clue to the cystic nature of the tumor. The position of the cyst is usually more superficial than one would expect to find with a kidney tumor. Pancreatic cysts usually occupy a lower position in the abdomen. Careful blood studies should always be made to rule out presence of blood dyscrasias, particularly chronic myeloid leukemia.

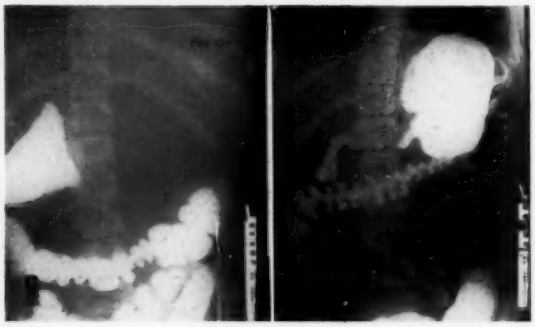

FIG. 1

Careful roentgen study will almost always be of distinct diagnostic aid. Benton called attention to the displacement

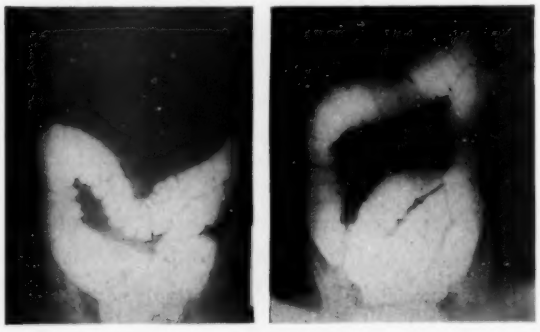

FIG. 2

of the lower third of the esophagus and the stomach to the right, and the downward displacement of the splenic flexure. He called attention for the first time to the

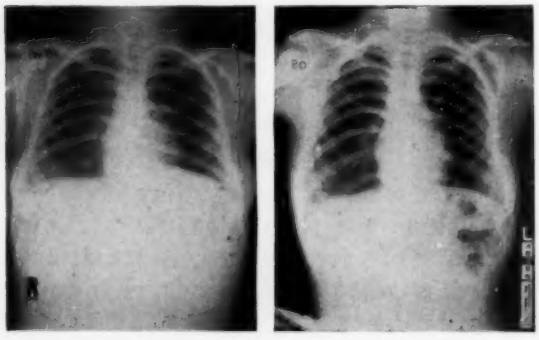

FIG. 3

return of these organs to their normal position following splenectomy. Benton feels that the downward displacement of the splenic flexure is almost pathognomonic of large cyst of the spleen. Novak reports a downward displacement of the stomach in the roentgen study of his case. Tilton,[7] whose report followed Benton's, noticed the displacement of the stomach

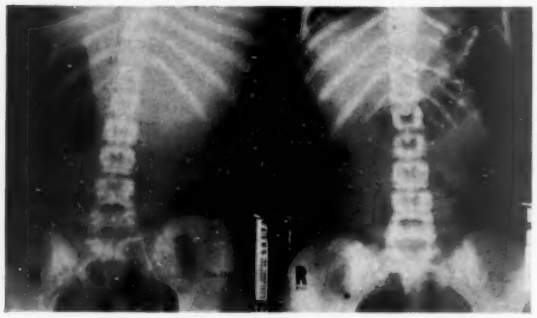

FIG. 4

to the right with a return to normal position following operation.

We have studied our case with regard to the chief neighboring organs, repeating

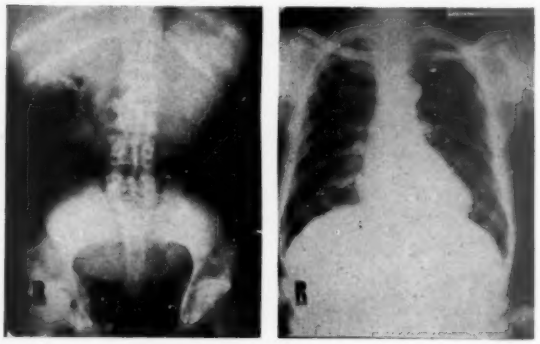

FIG. 5

the complete series of roentgenograms four weeks postoperative. As seen in Figure 1, the lower third of the esophagus and of the stomach is displaced far to the right as contrasted with the postoperative films

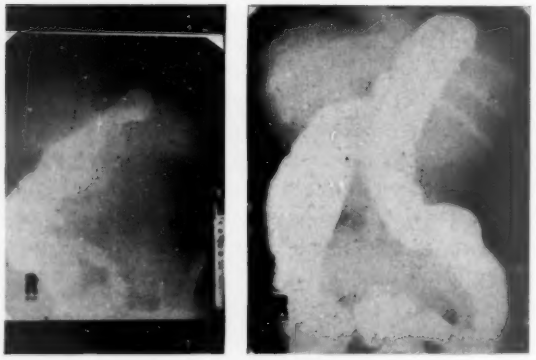

FIG. 6

in which the stomach is seen in normal position. Figure 2 shows a marked downward displacement of the splenic flexure which, as shown, returned to a normal position following operation. In our case the left diaphragm, as seen in Figure 3, is higher than the right and the transverse diameter of the heart is increased as compared to the postoperative film, which shows the diaphragm again in normal position and heart normal in size.

The plain film of the abdomen (Fig. 4) shows spreading of the lower left ribs, obliteration of the left psoas muscle, and displacement of the left kidney downward, all returning to normal position after the operation.

We have had the opportunity since studying this case to study a man, aged fifty-three, with chronic myeloid leukemia and marked splenic enlargement. The spleen in this case extended into the pelvis and to the midline. The film of the chest (Fig. 5) shows the left diaphragm in normal position, and the film of the abdomen shows a large mass, but no spreading of the ribs, displacement of the kidney downward, or obliteration of the psoas muscle. Figure 6 shows the descending colon and stomach displaced to the right, while the splenic flexure and cardiac end of the stomach are in normal position. Thus, it is seen that the spleen in which the enlargement is downward and anterior, does not displace the neighboring organs in the same manner as in the case of the young girl reported above.

Fig. 7

Fig. 8

SUMMARY

1. A case is reported of non-parasitic cyst of the spleen.

2. This condition is rare, occurs more often in females, has a vague symptomatology and is characterized by a left upper quadrant tumor.

3. Roentgen examination is of distinct aid in the localization of this tumor in the spleen.

4. It is believed that roentgenological study of abdominal masses, with a view to displacement of neighboring organs, may be of distinct value in localization.

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THE "PHRYGIAN CAP" DEFORMITY OF THE GALLBLADDER

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THE developmental anomaly of the fundus of the gallbladder, known as the "Phrygian cap" was described by Bartel in 1916. Boyden, in 1935, divided the anomalies into two distinct types: the concealed or retroserosal type and the serosal type. Boyden called attention to the fact that little notice was paid to the anomaly until after the Graham-Cole method of visualizing the gallbladder came into general use. Bronner and others have suggested that the deformity has clinical significance.

FIG. 1

During the course of the preparation of operative gallbladder specimens by a method of distending and drying the fresh specimen that was first seen in the laboratory of Dr. Sweet at Cornell, the "Phrygian cap" deformity has been frequently noted. In the first 100 specimens there were 6 with the characteristic deformity of the fundus. This series of specimens included those with chronic cholecystitis, with and without stones. The preoperative Graham-Cole roentgen examination failed to show the gallbladder in the first specimens noted. The postoperative distention of the specimens with bromide solution gave a typical shadow of the deformity (Fig. 1).

Prior to this time, roentgen shadows of a similar nature had been noted in patients who did not come to operation. They had frequently been diagnosed as adhesions and extraneous bands. A further collection of specimens has revealed similar deformities in patients in whom the preoperative roentgen examination revealed the septum-like deformity in the fundus (Fig. 2), and a stone. The dried specimen in this instance is seen in Figure 3, No. 7.

In Figure 3, a number of specimens have been arranged to show the type of septa encountered. The septum in the first specimen (No. 1) extends one-quarter of the diameter of the fundus. In succeeding stages the septum extends farther across the fundus. In No. 4, the septum extends across the fundus and the compartment is divided by a septum so that there are three distinct compartments to the fundus. Injection through the cystic duct

FIG. 2

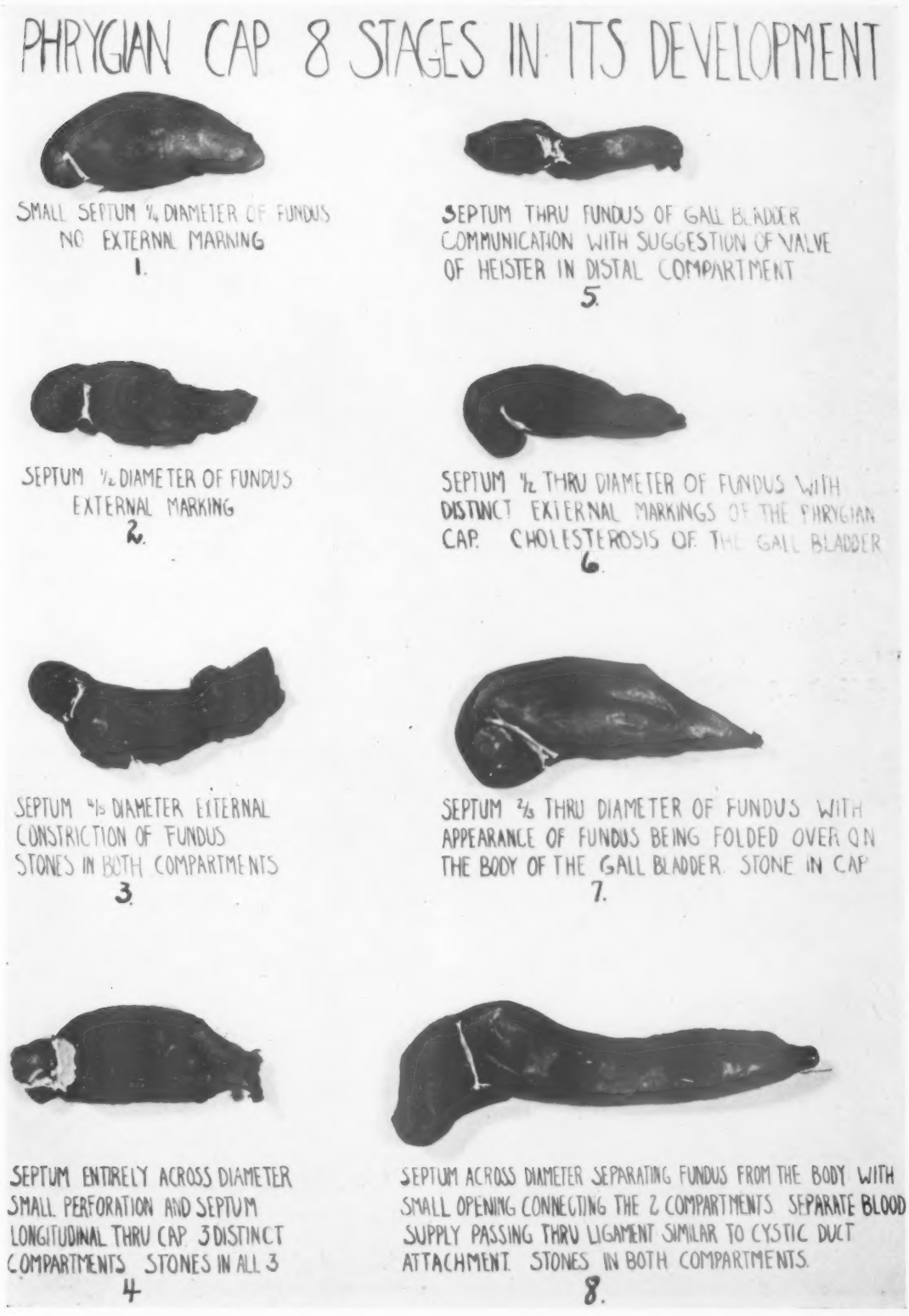
PHRYGIAN CAP 8 STAGES IN ITS DEVELOPMENT
SMALL SEPTUM ¼ DIAMETER OF FUNDUS NO EXTERNAL MARKING
1.
SEPTUM THRU FUNDUS OF GALL BLADDER COMMUNICATION WITH SUGGESTION OF VALVE OF HEISTER IN DISTAL COMPARTMENT
5.
SEPTUM ½ DIAMETER OF FUNDUS EXTERNAL MARKING
2.
SEPTUM ½ THRU DIAMETER OF FUNDUS WITH DISTINCT EXTERNAL MARKINGS OF THE PHRYGIAN CAP. CHOLESTEROSIS OF THE GALL BLADDER
6.
SEPTUM ⅔ DIAMETER EXTERNAL CONSTRICTION OF FUNDUS STONES IN BOTH COMPARTMENTS
3.
SEPTUM ⅔ THRU DIAMETER OF FUNDUS WITH APPEARANCE OF FUNDUS BEING FOLDED OVER ON THE BODY OF THE GALL BLADDER. STONE IN CAP
7.
SEPTUM ENTIRELY ACROSS DIAMETER SMALL PERFORATION AND SEPTUM LONGITUDINAL THRU CAP. 3 DISTINCT COMPARTMENTS STONES IN ALL 3
4
SEPTUM ACROSS DIAMETER SEPARATING FUNDUS FROM THE BODY WITH SMALL OPENING CONNECTING THE 2 COMPARTMENTS SEPARATE BLOOD SUPPLY PASSING THRU LIGAMENT SIMILAR TO CYSTIC DUCT ATTACHMENT. STONES IN BOTH COMPARTMENTS.
8.

Fig. 3

FIG. 4

of this specimen revealed the compartments communicating, although the openings could not be found in the dried specimen (Fig. 4).

FIG. 5

Specimens No. 5, 6, 7 and 8 in Figure 3 show an increasing extent in the external anomaly or groove from the top, a small external sulcus, to the bottom. No. 8 appears more like an attempt to form an additional gallbladder; the "Phrygian cap," when viewed alone, has a distinct aperture about the size of a cystic duct opening, the fold of peritoneum in the sulcus resembles that enclosing the cystic duct and in this

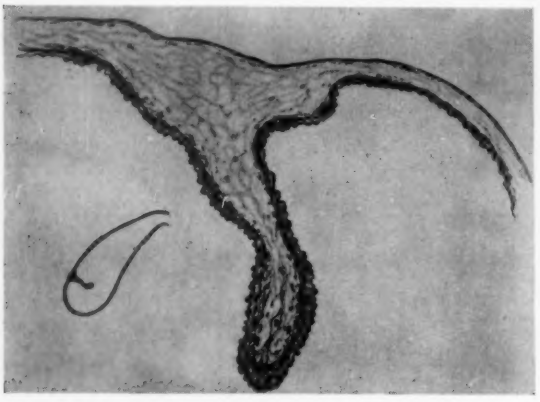

FIG. 6

FIG. 7

peritoneal fold are gathered the blood vessels that supply the "Phrygian cap," resembling a cystic artery and vein. The external appearance of the specimen is shown in Figure 5.

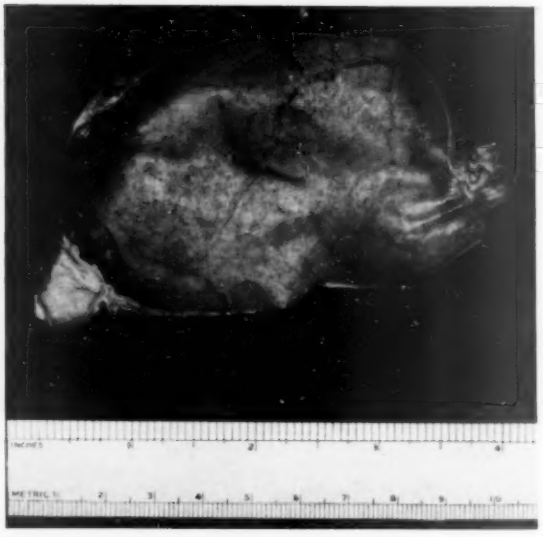

FIG. 8

The pathological section of the septa in our cases has shown the normal musculature of the gallbladder to be present (Fig. 6). While the musculature of the septum is

normal certain changes in arrangement of muscle bundles are found that in the absence of inflammation can only be due to embryonal development. These anatomical variations in muscle and blood vessel distribution seem significant since they are found only with the "Phrygian cap." Further studies are in progress by one of us in an attempt to correlate the gross and microscopic findings.

The possible embryological defects that could cause a deformity of the fundus and the remains of a septum are discussed at length by Boyden. In the specimens collected in this series, there are factors that suggest the incomplete vacuolization of the gallbladder (Fig. 7), the formation of an aberrant valve of Heister (Fig. 3, No. 5), and the attempt at the formation of an additional gallbladder (Fig. 5).

The usual method of preparing the collapsed gallbladder in fixing solutions will fail to show the septum, unless the specimen is fixed in the distended state and sectioned longitudinally (Fig. 8).

The clinical significance of the "Phrygian cap," as claimed by Bronner, is difficult to establish from a study of operative specimens alone. In our experience, there have been many patients in whom the anomaly could be seen in the roentgenogram, and there were no physical signs of gallbladder dysfunction or bile stasis after the patient had been completely examined. At the present time, the roentgen findings of a septum division in the fundus of the gallbladder is not thought to be sufficient to justify a diagnosis of disease of the organ unless it is accompanied by distinct evidence of bile stasis or cholelithiasis. The presence of the septum plays no part in the selection of patients for cholecystectomy. In no instance in which the roentgenogram has shown a septum division have adhesions of the fundus of the gallbladder been found at operation. Likewise, in no instance of pericholecystitis noted at operation has the distended specimen shown a characteristic external or internal anomaly of the "Phrygian cap" type.

In reviewing 1,000 of the more recent cases in which cholecystography had been employed, about 4 per cent of the cases showed septal divisions corresponding to the "Phrygian cap" deformity, a typical example of which is illustrated in Figure 9. In the majority of these cases where no other evidence of morphological or functional abnormality was observed, this defect was considered to be of a congenital nature and of no pathological significance.

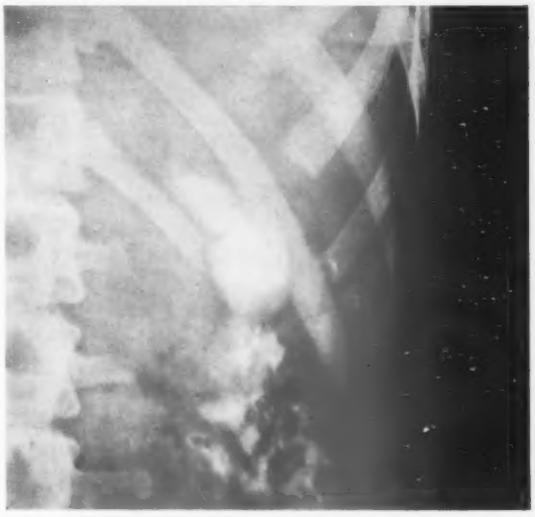

Fig. 9

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CARE OF THE CANCER PATIENT*

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WHEN dealing with cancer cases, one is quick to learn that numerous conditions arise which are not strictly concerned with diagnosis or treatment. Most of these conditions fall under the heading of care. The intelligent care of the cancer patient means a considerable decrease in the burden which must be borne. A fair-sized book could be written on the proper care of these unfortunates, but one finds surprisingly little on the subject in the literature.

The care of the cancer patient will be considered under the following headings: (1) mental hygiene; (2) physical hygiene and general care; (3) pain, including surgical procedures and complications; (4) irradiation. Since the care will vary according to the types of cases it seems feasible to classify them thus: (1) curable and borderline cases; (2) advanced cases. The diagnosis or treatment will not be considered and no attempt will be made to suggest those which should be hospitalized and those in which hospitalization is not advised, as this is a problem to be solved according to the local hospital facilities and the financial means in each individual case. A logical classification of chronic cancer cases with respect to hospitalization and non-hospitalization in large cities is adequately discussed by Kaplan[19] in a recent publication.

MENTAL HYGIENE

The mental hygiene, or psychology, as far as the patient himself is concerned, is variable. Each patient should be accepted as a new individual problem, different in some respects from all previous cases. Lacassagne[23] and others have used the policy of not telling the cancer victim his true condition. We believe, on the other hand, that an estimate of the emotional status of the individual should first be determined. This can be done with a fair degree of accuracy by the physician as he takes the history of the case.

In all curable and borderline cases wherein the emotional stability is good, they should be told their true condition. This will cause them to realize more fully the importance of treatment, will insure a closer conformity to the rules and instructions of treatment and will increase the cooperation necessary for successful follow-up. If the patient is told the truth, it is then his responsibility to comply with the prescribed therapeutic procedures; if he is deceived, the responsibility rests on the physician to obtain perfect cooperation from the patient. Emotionally unstable individuals, on the other hand, should not be told that they have cancer since the resulting phobia may prevent the harmonious management of the case and remove the optimal possibilities of cure.

When a patient is told he has cancer, he should always be assured that it is not a blood disease and that it is no disgrace. *At the onset the family should be informed that the disease is not contagious and that it does does not imply any stigma.* This is important, since many patients do not receive the proper nursing care in their homes because the members of the household fear that they may contract the disease.

One has frequently observed in a family much anxiety and overwhelming sympathy when cancer is first discovered in one of their number. Flowers, books and numerous tokens of love are showered on the unfortunate one but, as time passes, the patient notices a decrease in the attention shown him and a lack of interest in his increasing discomfort. At the time when he

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most needs real friends, they are weary of caring for him. He recognizes that he is a burden. This realization coupled with his suffering makes his existence unbearable. It is the duty of the physician when directing the care of an incurable case to forewarn the family of this tendency, thereby attempting to bolster up their continued sympathy and to prolong their kindliness.

We are of the opinion that advanced, hopeless cases should not be told their true condition and that at all times optimism and encouragement should be the keynotes. An exception arises when the mainstay of a family or one with business responsibilities requiring his final disposition develops an incurable cancer. The nature of his malady should be broached to him in the form of a possibility, with suggestions that he make whatever provisions he chooses, since the ultimate outcome of his case is uncertain. The family physician is usually in a better position to know the situation and to carry out this detail.

It is imperative that a responsible member of the family be fully informed as to the exact nature of the case and be frequently posted regarding the changes during the course of treatment or care. The physician is expected to give the family a prognosis in every case. This can be done intelligently and tactfully, always avoiding definite estimation of the duration of life, since cancer notoriously fools the best of prognosticators.

It is often a good plan, when instituting radiation therapy for palliation in the incurable, to tell them that their symptoms may be worse for a time. As they gradually decline and the suffering becomes more intense, they take courage in the belief that this was what the doctor had expected. So long as these sufferers have hope, life is less burdensome and they are easier to handle.

At times, the oncologist does not keep closely in contact with the family physician who refers the case. The latter too often sends the victim to a specialist, then retires to the background. Quick[28] states that the physician who devotes himself to malignant diseases too often criticizes the family physician's errors, particularly in establishing a diagnosis and in getting treatment started. It is far better for the specialist to enlighten the family physician on the problems involved in the active care and treatment of the patient, since the family doctor is in a better position to maintain the morale of both the patient and his family. By urging the family physician to be present at operations his interest is stimulated and he is more cognizant of the newer methods employed in cancer therapy.

PHYSICAL HYGIENE AND GENERAL CARE

Many of the procedures included in the physical hygiene fall under the heading of nursing care. In institutions for malignant diseases it is advantageous to employ graduate nurses having special training. Kress[22] believes that nurses should at least have a general knowledge of the disease and should be cheerful, hopeful, encouraging and always considerate of the patient's state of mind. In our institution where only graduate nurses are employed, the members of the staff, during each year, give lectures and demonstrations to the nurses about the various phases of cancer.

Appetite and diet, of course, vary with the location of the cancer and its curability. Generally a high caloric, palatable diet, rich in vitamins, is prescribed. An exception, of course, is in the far-advanced, helpless cases requiring frequent large doses of opium. The appetite may be stimulated by insulin, using 15 to 45 units daily. Tonics containing iron, whiskey and other alcoholic beverages are often useful.

The greatest dietary problem comes with cancer of the alimentary tract, especially of the stomach, which eventually destroys gastric function, reduces its capacity, and impairs peristalsis. For these cases Rehfuss[29] suggests mechanically reducing food before it is ingested—meat in a grinder and vegetables in a collander. Cooked cereals

and meat extracts may also be given. Extraoral saline, glucose and blood transfusions are often required in curable and borderline cases to combat dehydration and other constitutional symptoms.

In many mouth and throat cases nasal feedings over long periods of time are necessary. The nasal tube should be removed, cleaned and reinserted at frequent intervals. The patients can often be taught to feed themselves from suspended containers or from syringes. When indigestion and dry mouth follows irradiation over the salivary glands, the patient's digestion and appetite may be improved by the use of takadiastase in 5 grain doses before meals.

The care of severe nausea and vomiting will be discussed later in the paragraphs devoted to irradiation. Routinely, we give orange juice with sugar and 10 minims of viosterol three times a day to all patients receiving roentgen irradiation. The patients are encouraged to eat candy. Diets for postoperative cases are left to the surgeon's discretion, as in other types of surgery.

Whenever feasible, every case should be ambulatory, but not to the extent of fatigue. Regardless of the degree of advancement of the disease, to be up and about or in a chair and out of doors serves to keep up the morale, lessens the likelihood of secondary pulmonary complications, delays the formation of decubitus lesions, and maintains strength, appetite and vigor. Obviously, if there is danger of pathological fracture or if pain is aggravated the patient should be kept in bed.

Occupational therapy is distinctly advantageous in some cases. Many persons, crippled by their disease, have been taught simple, interesting and oftentimes useful occupations which serve to divert their attention from their troubles, thus decreasing the necessity for drugs and improving their spirits. Occasionally a patient has even been able to defray some of his expenses by simple occupational procedures during the last months or years of his life.

Physiotherapy has its definite place in the care of these patients. The outstanding example is the recovery or partial recovery by intelligent exercise of the use of an arm following a radical breast operation or of a leg following a radical inguinal and femoral dissection. Ultraviolet and other light treatments are sometimes valuable aids to granulating wounds, but it must not be forgotten that any heat or light treatments, especially those containing ultraviolet rays, produce skin erythema and should therefore not be directed to areas recently irradiated or to the portals which may soon require radiation therapy. The skin erythema, thus produced, will lessen the amount of radiation that can be given and may cause an epidermitis in cases already irradiated to the point of skin tolerance.

Of all forms of physiotherapy, hydrotherapy is probably the most beneficial. If daily warm bicarbonate of soda tub baths are given to patients with granulating postoperative wounds and even when large irradiated areas are present, the rapid disappearance of fibrinopurulent exudates, the stimulation of granulation tissue and the reduction of odor that results from such a comparatively simple procedure are phenomenal. The frequent irrigation of these areas with Dakin's solution and mild potassium permanganate solution, usually done in conjunction with the baths, also adds to the good results.

In caring for patients with lesions of the tongue, cheek, lips, gums, tonsils, salivary glands, larynx and the like, oral hygiene is of eminent importance. Some of the distressing features of all intraoral cases are fetid odors, excessive formation of mucus, and sloughs from necrotic areas. Attention to the teeth is very important and is often overlooked. All loose, decayed, broken teeth should be extracted, provided there is no danger of disseminating the cancer. In order to cleanse the mouth and subdue the fetor, antiseptic mouthwashes and gargles should be used several times daily. Auster[2] suggests the frequent use of chlorine solutions for this purpose.

In curable and borderline cases such scrupulous care will facilitate any type of treatment contemplated. In advanced cases, the oral hygiene is very important, both for the comfort of the patient and for the happiness of those with whom he comes in contact.

Gynecological and rectal cases require frequent douches and irrigations. The usual curable and borderline cases require less of this than do the advanced cases. Frequently repeated bladder, vaginal and rectal hygienic measures instituted at periodic intervals are necessary. Mild antiseptic solutions such as one to five thousand potassium permanganate solution serves this purpose. In advanced, necrotic, infected intravaginal lesions drainage of parametria by use of tubes may be required.[2] When skin irritation has occurred in the vicinity of a lesion, a dry soothing antiseptic talcum powder or a protective ointment containing bismuth subnitrate should be used.

Constitutional Diseases. We are fully in accord with Quick[28] when he says "No strenuous therapeutic procedure, operation or otherwise, should be undertaken for cancer without a careful appraisal of the patient's general physical condition quite apart from the immediate problems incident to the malignant condition." Thus cardiovascular disease, diabetes, tuberculosis, kidney disease, syphilis, and a score of other diseases need specific treatment and require the services of a competent internist. The statement is incorrect that antiluetic treatment of a patient with both syphilis and cancer is contraindicated if treatment by irradiation is employed. Such treatment will be found to enhance rather than damage the irradiation response.

PAIN

It has been said that "next to saving life, the relief of pain is the physician's most important function." This statement is even more strongly emphasized in caring for cancer cases. Fantus[9] remarks that "there should be no case in which the physician well versed in therapeutics cannot give relief to pain and distress by proper measures, not only without harm but with positive benefit to the patient. The patient has a right to expect relief from pain, for pain is in itself harmful, causing fatigue, insomnia and anorexia, depression of the circulation, psychic irritability and pessimism; and the longer pain continues the more intolerant does one become of it. . . . psychic measures must always be included in the strategem of relief. There are a number of psychic, vicious circles that may have to be broken in upon. For instance, pain creates anxiety, which concentrates attention on the affected part, and this increases the appreciation of the pain, for attention acts like a magnifying glass. Allaying anxiety in itself raises the pain threshold and makes possible the relief of pain with milder means than are required to annihilate the appreciation of a pain on which fear has fixed a watchful stand. This is how explanation and reasoning act on those whose minds are still accessible to reason. In those in whom either their nature or the pain engendered panic has made incapable of reasoning, nothing but the potency of suggestion will allay the anxiety; . . . . Obviously prompt and drastic relief of pain has in itself a high degree of suggestive value."

Auster[2] writes that the treatment of pain must be undertaken with a realization of the causative factors. It may be incidental to the local lesion, may be the result of local extension with invasion of perineural lymphatics or involvement of sensory nerves, or may be the result of distant invasion encroaching upon tissues far removed from the primary lesion. Behan[3] gives two causes and methods by which he believes pain is produced in cancer. First, the accumulation of toxic products in and around the cancer mass, all of which are increased when pyogenic organisms enter and infection is added. Second, mechanical factors, as the pressure which cancer tissue exerts upon the surrounding tissues and on their contained nerve fibers.

Relief from pain in curable and borderline cases does not give one the same amount of concern as it does in advanced cases. In patients wherein a form of operative therapy is contemplated, if time elapses in preparation for this surgical procedure, sedatives, like salicylates, barbiturates and codeine will suffice to relieve pain in the majority of cases. Drugs will be considered more fully later in the paper.

Our greatest problem with pain is in the advanced cases. Every effort should be expended to make the last days of these sufferers as comfortable as possible. Before resorting to the use of pain relieving medication, all other known procedures should be carried out.

Since most of the surgical procedures discussed in this paper have to do with the control of pain, the surgical care of cancer patients is included under this heading. The surgical care of cancer cases varies with each individual case. There are many things to be done surgically which add to the comfort of the patient and also prolong life. Some of the surgical procedures are done to restore or maintain normal function of certain organs or are devised to relieve pain and remove odors. In fact, as Quick[28] remarks, any reasonable and worthwhile procedure adding to the physical and mental well being of the patient, though in no way curative, is advisable.

There are certain operative procedures which are often employed for curable cases but which may be employed as palliative measures in incurable cases. The operative procedures that are used are tracheotomy, gastrostomy, gastroenterostomy, jejunostomy, colostomy, cecostomy, ureteral transplantation, etc. There are known cases of inoperable carcinoma of the stomach that have survived one or more years in comfort after the use of gastroenterostomy. Transurethral resection of the prostate is considered as only a palliative procedure.

There is another group of surgical procedures which are palliative and are used for the relief of pain. These include certain neurosurgical measures such as (1) intraspinal (subarachnoid) injections with alcohol; (2) the alcohol injection of peripheral nerves; (3) chordotomy (severing the anterolateral column of the spinal cord); (4) the division of peripheral nerves, and (5) pelvic sympathectomy. Any of these measures judiciously undertaken is well worth while and may remove all need for the administration of narcotics.

The methods and fundamental principles of the technique of injecting the subarachnoid space with alcohol are admirably detailed by Stern.[30] Our experience with a limited number of cases so far tends to confirm his good results. It is a practical and safe procedure when done properly, a dangerous one when done improperly. It does not paralyze muscles, although Behney[5] finds that injections are followed in some instances by muscular weakness. By relieving pain it allows more intensive roentgen irradiation or gamma irradiation to be given. Injections may be repeated frequently to control pain and single injections have been effective for six to eight months, the average, however, being about one month. The best results are obtained in cases of pelvic cancer and cases of pelvic and femoral bone metastases, although relief is often obtained in other malignant tumors, such as those of the stomach, large bowel and lungs.

The value of chordotomy has been amply discussed by Grant.[17] This gives a greater area of anesthesia than any other method. Motor function is unimpaired. Kahn[18] reports 33 cases in which chordotomy was performed for malignant growth of the uterus, prostate and large bowel. He believes that the fibrosis produced by roentgen and radium therapy is the cause of the most frightful pain, and that, moreover, irradiation can be more radically applied following chordotomy without fear of increasing the suffering. It should be undertaken only by those who are competent neurosurgeons. Frazier[13] prefers chordotomy or rhizotomy (section of the roots), as it is easier, since only one segment of the chord is exposed at the time of opera-

tion. For lesions of the face, neck mouth, tongue, and cheek, Fay[10,11,12] and Grant[15,16] advise the use of nerve injection, nerve section and rhizotomy. The method employed depends upon the location and the extent of the disease.

Pelvic sympathectomy in cancer of the cervix for pain not due to bone involvement, ureteral obstruction, or any invasion of peripheral nerves is a beneficial procedure in skilled hands. Behney,[5] who has had considerable experience with this procedure, emphasizes the necessity of choosing patients who are in reasonably good physical condition. In a series of patients on whom he performed this operation there were a number who lived only a few months. He does not regard the risk justifiable when the life expectancy is so short. For cases that are in poor physical condition he considers the injection of the posterior roots of the spinal nerves as the procedure of choice when the condition does not warrant sympathectomy. Intradural injections of alcohol gave less satisfactory results and some patients were made worse.

Behan[3] emphasizes the relief of pain brought about by ligating vessels supplying blood to the tumor, particularly in cases of cancer of the face and neck. He mentions cases wherein both external carotids have been ligated, with disappearance of the pain, but adds that after a varying amount of time has elapsed the pain returns.

Generally speaking, the careful cleansing of painful, ulcerated and discharging lesions, the removal of sequestra and the performance of minor surgical procedures, such as abdominal paracentesis and frequent thoracentesis, as often as necessary to relieve pressure, should be the first measures in relieving pain. When repeated abdominal paracentesis is necessary we use the Patterson button. It is a glass button which can be sutured into the abdominal wall and permits continuous drainage.

Foul odors emanating from advanced cases of cancer need not cause a great amount of concern as there are so many ways by which the majority of them can be effectively subdued. The surgical removal of bulky, odorous, discharging masses not only dispenses with the odor but makes the patient more comfortable and lessens pain.

Postoperative wound infections probably occur more frequently in tumor surgery than in any other class of surgical cases. Extensive denuded areas of skin are frequent. For these cases no single measure is as effective in cleansing and stimulating tissue growth as frequent irrigation with Dakin's solution. It should not be used constantly, however, over too long a period of time or too frequently. Better results are obtained when the wound is given one or two days of rest by irrigating with only normal saline solution. For stimulating postoperative denuded areas dichloramine T is very beneficial.

Dressings of incisions and lesions vary widely in cases of cancer, but several important principles apply to all dressings. To lessen discomfort, pain and odors, dressings should be changed frequently. Packs should be removed and reinserted often. In certain obviously hopeless, far-advanced cases, it is at times advisable to incise and drain tumor areas wherein secondary infections have caused the formation of one or more painful areas. Bulky, cumbersome dressings should be avoided, especially in ambulatory cases. Any repulsive, disfiguring, postoperative defect, visible to others in ambulatory cases, should be covered by a light dressing pending subsequent plastic work. Recent operative incisions must be isolated from nearby sources of contamination; especially is this true in the event of abdominal incisions in the presence of a colostomy or gastrostomy.

Emergency measures, although not for the relief of pain, are generally surgical and will be mentioned under this heading. Occasionally emergencies arise which require immediate action. In cases of cancer of the mouth and face hemorrhages are not infrequent both in the curable postoperative and in the advanced cases. As a rule, it is better to ligate the main branch of an

artery supplying a tumor area than to try other methods. Not infrequently the external carotids will have to be ligated and rarely one of the common carotids.

At times it is necessary to perform emergency tracheotomy in laryngeal cancer receiving intensive roentgen therapy for a stenosis which is caused by an acute edema. Vaginal packing in intrauterine or cervical hemorrhage is mentioned for completeness.

Drugs are the sheet anchors of our armamentarium, but as Auster[2] has aptly stated: although the "terminal stages require liberal use of narcotics, the administration of opiates should be limited in those instances of probable long duration, on account of dangers of habituation and raising of the threshold effectiveness. Moreover, it has been found that acetyl-salicylic acid and the coal tar group (sometimes in association with small doses of barbiturates or even, when necessary, fractional amounts of codein) are usually effective in controlling general symptoms for extended periods. Amidopyrin, acetphenetedin, antipyrin and acetanilid are analgesic medicaments of increasing potency, in the order named, for the vast majority of pains." We fully agree with this statment.

It should be remembered that luminal (phenobarbital) and most of the other hypnotics are valueless in the presence of pain. They do not relieve pain but simply produce sleep when restlessness and insomnia exist not as a result of pain. These hypnotics in average doses are efficacious only when the patient and his surroundings are conducive to sleep.

The more potent drugs at our disposal are dilaudid, pantopon, morphine, and scopolamine. Most of the experimentation in recent years with dilaudid shows that it is equally as good if not superior to morphine for relief of pain in advanced cancer. Dilaudid has been discussed by Eddy,[8] Menard,[24] Paine et al.[26] and Stroud.[31] A very thorough study of dilaudid usage in cases of cancer is reported by Nathanson and Daland.[25] From a study of these articles, we conclude that this preparation is preferable to morphine in that its action is more rapid, smaller doses may be used, fewer gastrointestinal symptoms develop and tolerance to the drug does not develop as early. With this drug, best results are obtained by using small doses at more frequent intervals.

As for pantopon, a derivative of opium, Behan[3] and others believe that it has a more powerful action and is less disturbing to the patient than morphine. Our results with this drug have been less encouraging.

Morphine alone and in combination with scopolamine can, of course, always be relied upon. When the end is near scopolamine tends to make the patient unaware of his true condition until actual insensibility supervenes.

Any irradiation used in the curable and borderline cases is done with the idea of eradicating the disease. If pain persists during the course of intensive radiation therapy, it is obvious that this should be controlled by whatever means is considered feasible.

The story is different in advanced cases. Here radiation is used in smaller doses for the control of pain and for growth restraint. In bone metastasis and ulcerating, discharging, painful lesions much can be done to add to the comfort of the patient by mild roentgen therapy. In inoperable gastric cancer, roentgen therapy not only prolongs the lives of many cases but it also reduces their suffering.

In patients not having reached the menopause, roentgen castration gives distinct relief from pain in cases of osteolytic metastases. Presumably, the motivating factor causing destruction is inhibited, and recalcification takes place. The duration of the beneficial effects is usually from six to twelve months. From Geschickter[14] it was recently learned that when bone absorption begins to recur and the pain reappears, the process can be retarded by the use of theelin. Theoretically after ovarian function has been destroyed, the inhibitory factor has been removed from the pituitary gland and prolan A is secreted in excess.

This will bring about a reactivation of the osteolytic processes. The theelin is therefore used to inhibit the over-production of prolan A.

On the above hypothesis, we have instituted treatment directly to the overactive pituitary gland. In six to twelve months, or whenever pain begins to reappear, we treat the pituitary with roentgen irradiation. The few cases treated in this manner have had less pain. We have not used the method long enough, however, to offer a convincing report.

While discussing the endocrine glands and their effect on cancer, it might be well to mention that a warning should be given to the family physician that he refrain from the use of theelin or other ovarian extracts for menopausal symptoms in cases of breast cancer since growth stimulation has been noted from their use.

Among the other methods used to prevent pain in advanced cases, calcium may be mentioned first. Behan[4] has used this in various forms with good results. In 1933 he reported that calcium has an action on the perceptive centers of the central nervous system so that irritative impulses are less acutely perceived, and it may be reasonable to suppose that this action aids in decreasing the pain perception in cancer. He gave calcium by mouth, intramuscularly and intravenously in the form of gluconate, also by mouth in the form of lactate. We have had favorable results with the administration of calcium in large doses by mouth and intravenously to relieve the pain of bone metastases.

Behan[4] also found that parathyroid extract used to supply serum calcium did so at the expense of the bone calcium and metastases seemed to occur more readily. This practice was therefore discontinued.

In 1934, Körbler[21] reported favorable results with injection of venom of the *Vipera amodytes* which is rich in neurotoxic elements. Kaplan[20] states that in a recent authoritative statement before the Academy of Medicine in Paris, Lavaden of the Curie Institute, who has repeated certain work of others with cobra venom, reported that cobra venom is not useful in the treatment of cancer pain.

A vast amount of work has been done in cancer therapy by the use of the heavy colloidal metals, gold, lead, and the like. The results are conflicting. If they are effective in reducing the size of the tumor masses, the pain may in turn be ameliorated.

Numerous other procedures reported to have analgesic as well as therapeutic qualities, such as the acidosis treatment, ensol, fever therapy, topical applications, and the like have not established themselves as useful in the care of the advanced case.

IRRADIATION

From a therapeutic standpoint preoperative irradiation is the tendency in the best tumor clinics today. No detailed discussion of its merits will appear in this paper. Suffice it to say that if irradiation precedes operation it is possible to gauge the radiosensitivity of the tumor, thereby removing the probability of operating upon tumors that might respond to irradiation alone. Frequently preoperative irradiation reduces the size of the tumor and at the same time eradicates gross secondary infections. This is particularly true in cancer of the cervix. By this method there is a lessened likelihood of metastasis, and the field in every respect is better prepared for surgery. During this period of irradiation, pain is sometimes made to disappear, weight and strength are increased, and the general physical condition of the patient is improved.

When the patient is receiving intensive irradiation, the necessity for frequent complete blood studies cannot be too strongly emphasized. If the white cells drop below 2,000 or the hemoglobin below 50 per cent, it is our practice to resort to some means of active therapy. Repeated blood transfusions are often necessary, *particularly in patients in whom blood elements have been impoverished by disease. Anemias resulting from hemorrhage need cause less concern*

since they frequently improve with the cessation of bleeding during the period of roentgen therapy. In the more mild anemias, liver extract and iron preparations are of distinct value. Some have used pentose nucleotides with satisfactory results. It has been an aid to us in a few cases. Various procedures have been recommended for the disproportionate reduction in white cells. We have tried injections of sterile milk with little effect. Typhoid vaccines and the use of drugs to produce sterile abscesses have been recommended. Because of his belief that the barbiturates have a tendency to reduce the white cell count, Arneson[1] favors the use of opiates for pain in irradiated cases.

Concerning radiation sickness, there are numerous methods employed to combat the nausea or vomiting which results from irradiation. In the severe forms, normal saline solution and glucose (5 per cent) intravenously and subcutaneously are most valuable. To allay nausea and vomiting chloretone in 10 grain doses will give temporary relief. It is our practice, as previously stated, to give all patients receiving intensive irradiation 10 minims of viosterol and 6 to 8 ounces of orange juice with sugar three times a day. Liver extract in doses of 1 to 3 c.c. given intramuscularly at one to three day intervals is foremost in effectiveness. Young[32] has pointed out the advantages of this procedure. The chief objection which is raised to the use of liver is the severe pain produced by the intramuscular injection. Concerning this, Young writes: "We have learned that many of the painful reactions which follow the intramuscular injection of liver extract can be prevented if a certain site is selected and a definite technic carried out. The drug is injected into the buttock just above and lateral to the intersection of a vertical line, drawn midway between the lateralmost aspect of the buttock and the gluteal crease, and a horizontal line which crosses the buttock at the level of the sacro-coccygeal junction. Just before injection the buttock is depressed, flattened and drawn caudad by the palm of the left hand. A number 20 gauge needle 1½ to 2 inches long is used, the point being directed slightly towards the patient's feet." Desjardins[7] has used capsules of sodium amytal inserted into the rectum immediately after each roentgen treatment with satisfactory results. Nembutal is recommended as beneficial for roentgen sickness. By beginning roentgen therapy in small doses and thereby establishing a tolerance of the individual to the effects of the rays, Coutard[6] finds less general reaction and radiation sickness. The mental attitude of the patient must not be forgotten in the prevention of radiation sickness. Frequently the family physician, intern or nurse will advance the idea to the patient that nausea will appear and continue throughout the period of therapy. This idea undoubtedly precipitates and aggravates the complaint.

Cases of brain tumor present unusual problems and for this reason they will be considered separately. Concerning these patients, Pendergrass[27] writes that extreme care must be taken early in the treatment to avoid increased intracranial pressure and the extreme headache and vomiting resulting therefrom. As a rule, patients are more sensitive during the first week of the therapeutic course, and it is during this time that small doses of radiation are of extreme value in minimizing the symptoms due to increased pressure. The first day the patient is given not more than 50 r, measured in air. If no reaction results the dose is increased to 75 r on the second day, to 150 r on the third day and to 200 r on the fourth day. In many instances, by this slow increase in dosage, as much as 300 r may be given to one portal by the sixth day with impunity. Frequently, when six to eight portals are employed, it is necessary to treat two portals a day and in these cases 300 r may be given early in the morning to one portal and the same dose repeated in the afternoon to another without producing any ill effects. At times patients reacting unfavorably to 300 r at one sitting will easily tolerate 400 r, if 200 r is

given in the morning and 200 r late in the afternoon. In patients with considerably increased intracranial pressure, it is only possible at times to give a total daily dose of 150 to 200 r. Patients who have been operated upon and who have decompressions develop no other complaints than severe headache and vomiting or an exaggeration of the symptoms which brought the patient to the hospital. One must, therefore, be more careful in dealing with patients with brain tumors who have no decompression flap, particularly in cerebellar tumors, since there is no means of reduction of the increased pressure. These patients should be watched closely and if the danger signs which usually appear within four to six hours are noted, the immediate use of 50 per cent glucose intravenously is indicated. The danger signs of increased intracranial pressure are: (1) a rising blood pressure or an increase in pulse pressure; (2) a slowing pulse rate (below 58 is usually abnormal); (3) a slowing or irregularity of breathing (respirations below 16 are usually significant), and (4) drowsiness or impairment of consciousness. Since any or all of these signs may be the forerunner of a sudden complete respiratory failure, their appearance should be promptly reported to the neurological consultant in order that appropriate treatment may be instituted. It is inadvisable to assume the responsibility of the roentgen treatment of these cases without the cooperation of a competent neurosurgical consultant. Patients with pituitary tumors are watched and checked closely with visual field and eyeground examinations. Brain tumor patients with field cuts are also checked opthalmologically, at least once, during their therapeutic series. In all of the patients the hair over the treated areas receives from 1,600 to 2,800 r. In many cases, at the end of the year the hair has returned, but when irradiation is repeated at the end of three to four months over the same portals the patients should be warned of the probability of alopecia.

With the adoption of heavier dose techniques the occurrence of epidermal and epithelial reactions becomes more troublesome. It is always wise to explain to the patient and to some responsible member of the family that a marked reaction will occur and that secondary skin changes may result, justifying, at the same time, the severity of the treatment by calling attention to the inevitable consequence if the neoplasm is not eradicated. The radiologist should fortify his position by a positive biopsy report from a competent pathologist and, when possible, *serial photographs of the lesion should be kept in the files*. In the treatment of oral and pharyngeal lesions particularly are these reactions encountered. The epithelitis is benefited by frequent irrigations of the mouth, as has been previously mentioned. One should always make sure that all artificial dentures, because of their metallic content, are removed before radiation therapy is instituted. For the radiation dermatitis which develops during the treatment, mild dusting powders, vaseline and Dodd's solution are of distinct benefit. Nupercaine is recommended when the reaction is painful. It is well to remember that when phenol is used in strengths of 0.5 per cent or more the lesions should not be covered. The thorough cleansing of the skin prior to irradiation when these applications contain metallic substances must not be forgotten, since secondary rays are produced by their presence. For the same reason, mercurochrome should not be used on the skin over the fields being irradiated. Adhesive tape will also aggravate the skin reaction. After the roentgen therapy has been completed, an ointment containing zinc oxide, bismuth subnitrate, glycerine and phenol is most helpful.

CONCLUSIONS

An attempt has been made to assemble and discuss some of the more important problems arising in the care of cancer patients. Little has been added to the general fund of knowledge concerning the care of these cases but it is hoped that a collection of these observations may be helpful

to the physicians engaged in the treatment of these unfortunate individuals.

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DISCUSSION

DR. KENNETH D. A. ALLEN, Denver, Colo. Two very important drugs which Dr. Downs mentioned I will discuss very briefly. One is calcium glucinate and the other is dilaudid. He advises calcium gluconate for control of the pain. We have found it a very valuable adjunct in our work. We also agree with him that dilaudid in small doses is often a good drug to take the place of morphine as less of it will control the pain.

We have found the use of calcium gluconate also valuable in combating nausea. In using it for both pain and nausea we find it effacious and leave a routine order on the floors in the hospital where we have our patients, to give 10 c.c. of calcium gluconate intravenously for nausea at the time the nausea occurs and have been very pleased with the results.

In addition to remedies which Dr. Downs has mentioned for foul discharges from sinuses, and from the vagina in carcinoma of the cervix, we have found that glucose, 50 per cent solution, injected into the vagina or into the sinus, and left for several hours and then washed out with normal saline occasionally produces rather phenomenal results, while we are waiting for the results of the roentgen treatments.

Just one word about home treatment. Some of us have private patients who are not too well-to-do. Our free patients are cared for by social service at home, and very good work is done by some departments of the social service, but we are inclined to neglect home treatment of our not-too-well-to-do private patients. We should see whether our patient has sunlight and fresh air, that his room is near a bath room, whether he has to climb the stairs when he shouldn't climb stairs, and we should really supervise his diet because it is not always properly supervised by the patient's family.

And, to conclude, we should consult with the patient's relatives. We can add to the happiness of some of these victims by gaining the cooperation of the family. The patient asks his relatives a question and then they ask the doctor the same question. If we can arrange either to have the relative refer the question to the doctor or have both the relative and the doctor tell the patient the same thing, I believe we can add hopefulness and courage throughout the course of treatment.

Dr. Downs (closing). I want to thank Dr. Allen for his very helpful discussion. After hearing of the excellent results which he is obtaining in roentgen sickness by the use of calcium gluconate, I am wondering if it may not be the calcium content of orange juice which is entirely responsible for its therapeutic action. I have considered the fruit acid an important factor in promoting the absorption of the calcium salts.

Dr. Allen's suggestion that one should investigate and learn more about the home life of our patients is a phase which is not considered in this paper. It is certainly important and a worth while contribution to this subject.

CHANGES IN THE LUNGS AND PLEURA FOLLOWING IRRADIATION OF EXTRATHORACIC TUMORS*

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REACTION of the lungs and pleura to extrathoracic irradiation by means of roentgen rays, radium and other radioactive substances has been observed and recorded repeatedly during the past thirty years. In 1932, Desjardins[1] published a complete review of the experimental data on this subject. Recently, McIntosh[2] brought the literature up to date and described 4 patients with carcinoma of the breast in whom definite changes in the lungs and pleura following roentgen irradiation were noted in roentgenograms and necropsy material.

The following observations are recorded mainly to support those of McIntosh and others and to emphasize the fact that post-irradiation fibrosis must be given serious consideration in the differential diagnosis of pulmonary changes which appear subsequent to the treatment of extrathoracic lesions by the physical agents mentioned.

In a series of 51 consecutive patients with malignant tumors of the thoracic wall treated intensively by means of roentgen rays, radium and radon, definite roentgenographic evidence of post-irradiation changes in the lungs and pleura was found in 12 instances. This series included 47 cases of carcinoma of the breast, 2 cases of recurrent fibrosarcoma of the back, 1 case of hemangioendothelioma of the supraclavicular region, and 1 case of recurrent fibrosarcoma of the upper chest wall. The post-irradiation changes in the lungs and pleura were all observed in patients treated for carcinoma of the breast.

TECHNIQUE OF THERAPY

The roentgen irradiation was given with a machine of valve-condenser type operated at 180 kv. (constant potential), 8 ma., and 50 cm. skin target distance. The filters were 56 mm. oil and 0.25 mm. Cu plus 2 mm. Al (effective wave length of 0.195 Å; half-value layer of 0.67 mm. Cu). The portals used for the treatment of carcinoma of the breast usually were as follows: a direct portal, averaging 10×14 cm. in diameter, covering both the supraclavicular and infraclavicular regions; a second tangential portal, 16×18 cm., directed toward the anterior chest wall and including the sternal, intercostal and mammary regions; a third portal, 12×16 cm., directed toward the axilla and the lateral chest wall and tangentially toward the breast; and, at times, a fourth portal, 10×14 cm., directed toward the axilla from behind. Fifteen to 25 per cent skin erythema dose (S.E.D.), corresponding to 120–200 r (800 r as 100 per cent S.E.D.), was the usual dose given at one sitting. This dose was given to each portal three times a week. The total dose in one series of treatment was approximately 200 per cent S.E.D. to each portal. The technique of cross-firing likewise was used, whenever possible, in treatments directed toward portions of the thoracic wall other than the mammary region.

Radon was used in gold seeds of 0.3 mm. wall thickness. The technique of application has been described by Failla.[3] The radium used was in the form of platinum-iridium needles having a filter equivalent to 0.5 mm. platinum. Each needle held one to four cells, each of which contained 1.0 to 1.5 mg. of radium. In applying these needles, Keynes' technique was followed.[4]

REPORT OF CASES

CASE 1. I. V., female, aged fifty-one, was admitted to the hospital for treatment of carcinoma of the left breast. Her general health had been good and there was no history of

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chronic cough or hemoptysis. On June 27, 1933, radon seeds, 7,317 mc-hr., were implanted in the supraclavicular, infraclavicular, axillary and mammary regions of the affected side. A roentgenogram of the chest was made on the following day. The lungs were seen to be essentially clear except for slight clouding in the right apex which was interpreted as an old tuberculous lesion. There was no abnormal pleural shadow. The trachea and heart were in normal position. Radon seeds were seen in the above-mentioned areas (Fig. 1*A*).

fourth posterior axillary portal. Each portal received from 150 to 160 per cent S.E.D.

A roentgenogram of the chest (Fig. 1*B*) taken on May 3, 1934, showed definite increase of pleural shadow along the left axillary border extending from the apex to the base. There was a dense triangular shadow bridging the left lower cardiac and diaphragmatic shadows. This was interpreted as thickened pleura. The trachea and heart were slightly but definitely displaced to the left. There was no frank change in the parenchyma of the lung.

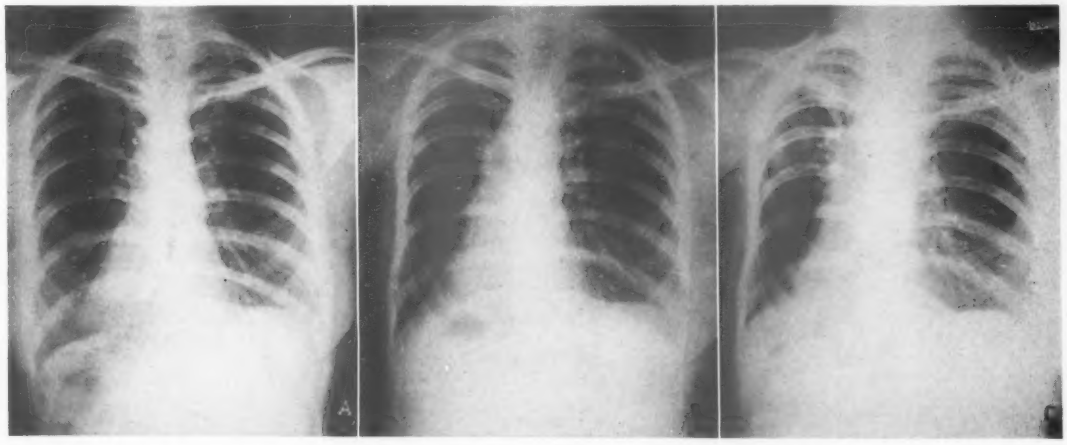

FIG. 1. Case 1. *A*. Chest before treatment. *B*. Twelve and eleven months after the first and second radon treatments respectively, and eight and six months after the first and second roentgen treatments respectively. *C*. One and one-half years after the last course of roentgen therapy.

A simple mastectomy was done on July 11, 1933, and more radon seeds were implanted, the regions treated being the left intercostal spaces close to the sternum as well as the areas treated on the previous occasion. A total of 7,717 mc-hr. was used at this time. Between August 16 and September 13, 1933, a course of roentgen therapy was given to the left supraclavicular, infraclavicular, axillary and breast regions from three portals, each portal receiving 210 per cent S.E.D.

On November 4, 1933, dissection of the axilla with removal en masse of the pectoral muscles was done. The patient recovered from the operation uneventfully. Further roentgen therapy was given between November 21 and December 14, 1933, to the same regions irradiated in the first course, with a total of 177 per cent S.E.D. to each portal. A third course of roentgen therapy was given in May, 1934, in like manner but with the addition of a

The patient remained well and there was no symptom or sign to suggest pulmonary disease. There was no fever and her body weight kept increasing steadily.

A follow-up roentgenogram of the chest taken in June, 1935 (Fig. 1*C*), revealed the pleural shadow to be more marked, the trachea to be deviated more to the left and slightly angulated at the level of the clavicle, and the heart also to be more displaced. The triangular shadow in the left cardiodiaphragmatic region was more pronounced and extended farther superiorly and laterally. The markings of the left upper lung were more dense. In the right lung, there were no changes other than those seen at the first examination.

Comment. This patient received a large amount of radiation with radon and roentgen rays over the anterior and lateral chest wall on the left side, more intense in

the upper areas. The pleural thickening and the increased markings and retraction of the lung, as seen in the serial roentgenograms, were due apparently to a reaction of fibrous tissue following the irradiation. These findings might have been interpreted as chronic fibrotic tuberculosis of the lung and pleura or as an infiltrative type of metastasis from the primary tumor, but the absence of pulmonary symptoms and signs, the excellent general health of the patient, and the time relation between the appearance of the intrathoracic changes and the irradiation were definitely against such a diagnosis.

CASE II. E. W., female, aged thirty-seven, was seen in July, 1934, for recurrent carcinoma involving the axillary and infraclavicular regions on the left side. A malignant tumor of the left breast had been discovered in June, 1932, for which a radical mastectomy followed by radium and roentgen treatment had been done in another hospital. The details of the radiation therapy were not known. A course of roentgen therapy was given in this clinic between July 18 and August 13, 1934, through four portals in the routine manner. A roentgenogram of the chest taken on August 8, 1934 (Fig 2*A*), showed a slight pleural shadow in the left chest along the axilla from apex to base and an increased shadow in the cardiodiaphragmatic region. Thin but definite clouding was seen in the left infraclavicular region. These changes were suggestive of minimal tuberculosis, but in view of the previous irradiation and the fact that the changes observed in the roentgenograms appeared subsequent to this treatment, they were thought to have been caused by the irradiation.

An exploratory operation in the infraclavicular and axillary regions carried out on September 15, 1934, revealed that carcinoma was still present and for this reason radon seeds, 1,383 mc-hr., were inserted. A second course of roentgen therapy was given in October, 1934. In January, 1935, the chest was again examined roentgenologically. The pleural shadow was more evident both in the axillary and the cardiophrenic regions. The trachea now appeared slightly deviated to the left. The clouding in the upper lung field had definitely increased (Fig. 2*B*).

A third course of roentgen therapy was given in February, 1935. Further roentgen examination in August, 1935 (Fig. 2*C*), showed that the changes observed previously in the left chest had become more extensive, particularly the clouding in the upper lung field and the deviation of the trachea and heart. The left upper lobe appeared to be retracted as indicated by its concave inferior border.

During the follow-up period, the patient

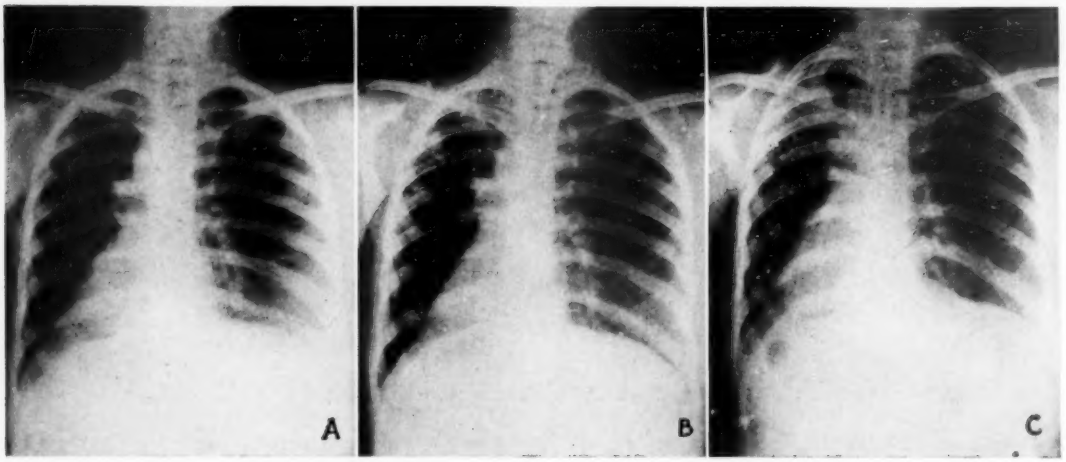

FIG. 2. Case II. *A*. At the conclusion of the first course of roentgen treatment. *B*. Five months after the first course of roentgen therapy, four months after radon implantation, and three months after the second course of roentgen therapy. *C*. Ten months after *B* and six months after the third course of roentgen therapy.

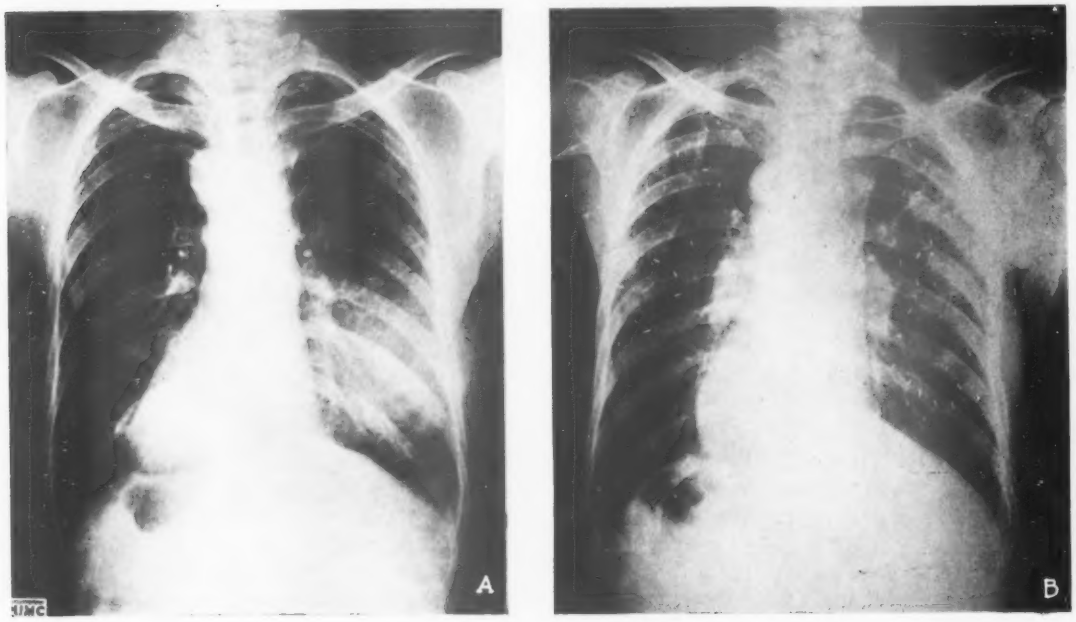

Fig. 3. Case III. *A*. Before treatment. *B*. Twelve and ten months after the first and second roentgen treatments respectively, and eight months after the radon treatment.

gained rapidly and maintained her body weight satisfactorily. There were no pulmonary symptoms or signs, and her general health was excellent. A careful record of the body temperature showed no fever. Examination by the concentration method of what sputum she could raise was negative repeatedly for tubercle bacilli. Guinea-pig inoculation was not done.

Comment. This case is comparable to Case I both in the nature and extent of the changes demonstrable in the lung and pleura and in the intensity of the irradiation used in treatment.

Case III. H. C., female, aged fifty-seven, had carcinoma of the right breast with axillary metastasis to each side. A roentgenogram of the chest before treatment (Fig. 3*A*) showed essentially clear lung fields except for a bundle of thickened markings in the right upper area, which were apparently scars of old tuberculosis. Clouding in the right lower chest area was due to the mammary tumor. There was no appreciable change in the pleura. A course of roentgen therapy was administered to the regions of the right breast in September, 1934, through four portals, each receiving 170 per cent S.E.D. and a second similar course was given in November, 1934. On January 8, 1935, radon seeds were implanted in the supraclavicular, infraclavicular, axillary and mammary regions and intercostal spaces on both sides. The dosages were 6,574 mc-hr. on the left side and 6,233 mc-hr. on the right.

A roentgen examination of the chest on September 10, 1935 (Fig. 3*B*), showed that in both lung fields the markings appeared increased, extending from the lung roots to the periphery. The changes were more marked in the right lung. Likewise, the mediastinal pleurae on both sides appeared to be thickened, more evidently so on the right side. The trachea was displaced slightly toward the right side.

The patient had no symptom or sign of pulmonary disease. There was no fever, and the body weight remained about the same during the period of observation. Examination of sputum by the concentration method was repeatedly negative for tubercle bacilli. Inoculation of the sputum into guinea-pigs was not done.

Comment. The irradiation used in this patient was bilateral and was not so intensive as that in Cases I and II. Correspondingly it is interesting to note that the changes in the lung fields, while less extensive, appeared on both sides.

CASE IV. L. C. W., female, aged thirty-two, was first seen in August, 1934, for postoperative, recurrent carcinoma of the breast involving the right mammary region and axilla. A roentgenogram of the chest at this time showed no evidence of pulmonary or pleural lesion (Fig. 4*A*). The shadow of the right breast was absent. A course of roentgen therapy was given between August 24 and September 18, 1934, and at the same time radon seeds, 7,636 mc-hr., were implanted in the supraclavicular, infraclavicular, and axillary regions and intercostal spaces on the affected side. A roentgenogram of the chest taken on February 7, 1935 (Fig. 4*B*), showed extensive pulmonary metastases on both sides. In the right upper half of the lung field, however, metastatic lesions were not seen. Instead, there were strands of dense, thick markings extending from the hilus to the periphery. There was also an increase of the right mediastinal and pleural shadows. The trachea was displaced and angulated slightly toward the right at the level of the clavicle.

Comment. It is interesting to note that the nodular metastatic lesions did not occur in the right upper lung where the irradiation had been heaviest. The changes present here were interpreted as due to the reaction of fibrous tissue following irradiation. This interpretation seemed most logical in view of the character of the lesion, the presence of pleural thickening and retraction of the trachea toward the right side.

CASE V. H. T. S., female, aged forty-seven, was treated for carcinoma of the right breast by means of simple mastectomy and implantation of radon seeds, 5,389 mc-hr., in the usual areas of lymphatic drainage on August 1, 1933. Two courses of roentgen therapy were given in September and November, 1933, respectively. A block dissection of the axilla and removal en masse of the pectoral muscles were done in January, 1934. Roentgen examinations during the period of the therapy showed a gradual increase of the shadow of the pleura and the lung markings in the right upper area. An examination in September, 1935, revealed that the pleural thickening along the axillary border and over the right upper lung field had remained unchanged. These changes were not present before treatment had been started.

CASE VI. N. J. P., female, aged forty-four, was treated for carcinoma of the right breast in December, 1934, by means of radical mastectomy and implantation of radon seeds, 10,272 mc-hr., in the areas of the regional lymphatics. Roentgenographic examination of the chest in January, 1935, showed a pleural shadow along the right axillary region and a veil-like shadow over the apical and clavicular regions. Previous to treatment the findings had been normal.

CASE VII. H. K., male, aged thirty-five, was seen in August, 1933, for carcinoma of the right breast with extensive axillary metastasis. A roentgenogram of the chest showed normal findings. On August 8, 1933, simple mastectomy and implantation of radon seeds, 9,453 mc-hr.,

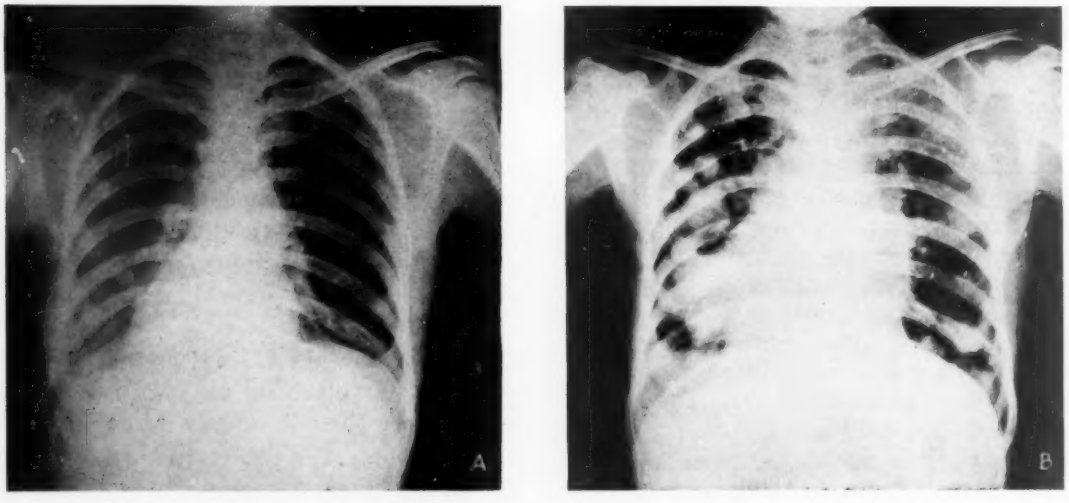

FIG. 4. Case IV. *A*. Before treatment. *B*. Six months after a course of roentgen and radon therapy.

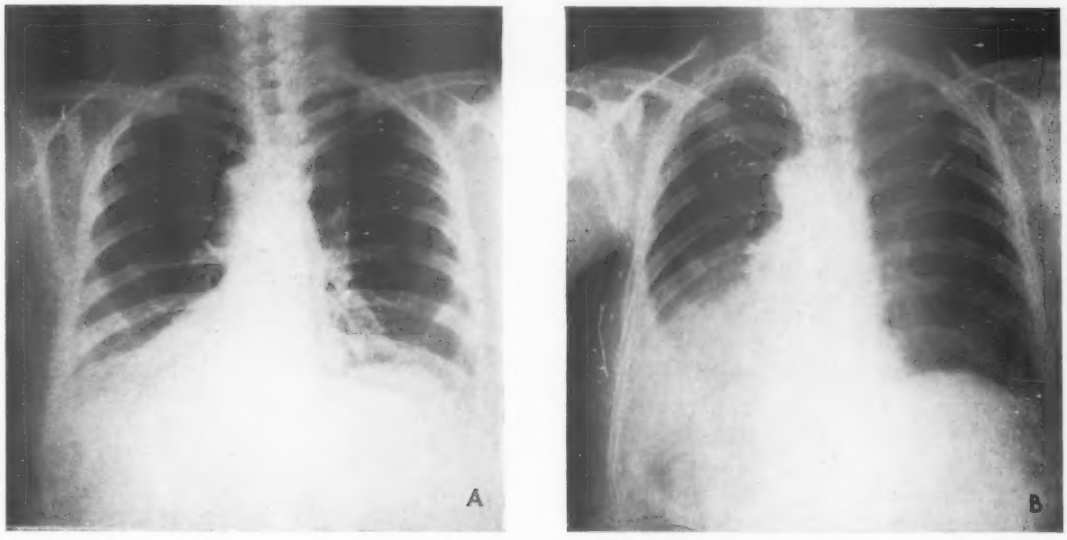

FIG. 5. Case XI. *A*. Before treatment. *B*. Five months after the first radon and radium therapy, and three months after the second radon implantation.

were done. A course of roentgen therapy was given in September, 1933. A roentgenogram of the chest taken in February, 1934, showed greatly increased lung markings which extended from the hilus to the periphery in the right upper area.

CASE VIII. K. T., female, aged fifty-four, with carcinoma of the right breast and axillary metastasis, in whom a roentgenogram of the chest appeared normal, was treated as follows: In April, 1934, simple mastectomy and implantation of radon seeds, 2,487 mc-hr., in the areas of the regional lymphatics was carried out. A course of roentgen therapy was given in May, 1934, and block dissection of the axilla together with removal en masse of the pectoral muscles and implantation of radon seeds, 5,973 mc-hr., was done in June, 1934. A roentgenogram of the chest taken in July, 1934, showed that in the right lung there were generally increased markings with irregular, dense streaks and slight pleural thickening in the upper area.

CASE IX. W. C. S., female, aged thirty-four, came to the clinic because of carcinoma of the left breast. A roentgenogram of the chest was normal. In August, 1932, radon seeds, 7,972 mc-hr., were implanted in the mammary, supraclavicular, infraclavicular and axillary regions of the affected side, and a month later another such treatment, 7,517 mc-hr., was carried out. A radical mastectomy was done in April, 1933, and a course of roentgen therapy was given in September in the routine manner. Roentgen examinations in August, 1933, and May, 1934, showed slight but definite pleural thickening in the left chest, particularly in the upper area.

CASE X. S. F. C., female, aged forty-eight, developed carcinoma in the left breast. Roentgenographic examination of the chest was negative. In May, 1932, radon seeds, 14,397 mc-hr., were implanted in the breast and the areas of the regional lymphatics. A radical mastectomy was done in August, 1932, and at the same time more radon seeds, 1,290 mc-hr., were implanted in the left upper clavicular area. Follow-up examinations with roentgenograms in October and November, 1932, showed definitely increased density suggestive of mild pleural thickening over the left upper lung field.

Comment. Cases V to X inclusive represent mild but definite changes in the lungs and pleurae following irradiation. During the period of observation, the patients remained entirely well without clinical evidence of pulmonary disease.

Acute Reaction. It has been our experience, as well as that of others, that patients receiving radiation therapy in the thoracic region frequently complain of dryness and sometimes of marked discomfort

or burning in the throat or neck. Many suffer from a dry hacking cough without raising sputum. These symptoms, which apparently are caused by irritation of the tracheal mucosa, usually disappear within a fortnight. We have observed a more serious reaction on two occasions in this series in which pleural effusion occurred a few days following the irradiation, with prolonged convalescence and low grade fever.

CASE XI. C. S. C., female, aged fifty-nine, was seen because of carcinoma of the left breast. A roentgenogram of the chest taken before treatment was started showed normal findings (Fig. 5*A*). In March, 1935, radon seeds, 3,527 mc-hr., were implanted in the left supraclavicular and infraclavicular regions, and radium needles, 38 mg., were inserted in the left intercostal spaces, axilla and mammary region, giving a total dosage of 6,200 mg-hr. On May 21, 1935, radical mastectomy was performed, and at the same time more radon seeds, 7,355 mc-hr., were implanted above and below the clavicle and in the axilla and intercostal spaces. During the first three days of postoperative convalescence, there was a slight febrile reaction which tended to subside, and the patient was apparently comfortable. On the fourth day, the fever rose and the patient complained of moderate pain in the chest, on the operated side. This lasted for a few days. The surgical wound was in good condition except for superficial necrosis of small portions of the skin flaps along the line of incision over the lower chest wall. There was no cough. The respiratory rate was slightly elevated. Physical examination revealed evidence of a large pleural effusion in the left lower chest without appreciable change in the position of the mediastinum. This finding was substantiated by roentgen examination. Aspiration was performed on eight occasions. Cultures of the fluid for tubercle bacilli and pyogenic organisms were uniformly negative. Roentgenograms were made repeatedly to follow up the intrathoracic condition. The effusion recurred promptly following each thoracentesis, and there was a persistent low grade fever. Repeated examination of the sputum for tubercle bacilli by the concentration method was negative. Guinea-pig inoculation with the sputum or fluid removed from the pleural cavity was not done. A roentgenographic examination on August 8, 1935 (Fig. 5*B*) still showed a considerable amount of fluid.

CASE XII. A. A., female, aged forty-eight, developed bilateral carcinoma of the breast. A roentgenogram of the chest taken before treatment was instituted showed normal findings except for the presence of an old fracture of the sixth and seventh ribs at the right posterior axillary line (Fig. 6*A*). In February, 1933, simple mastectomy and implantation of radon seeds in the breast and the areas of the regional lymphatics, 9,728 mc-hr., on the right side and 5,208 mc-hr. on the opposite side, were done. In April, 1933, more radon seeds, 3,756 mc-hr., were implanted on the right side. A second roentgen examination of the chest in June, 1933 (Fig. 6*B*), showed that there was definite evi-

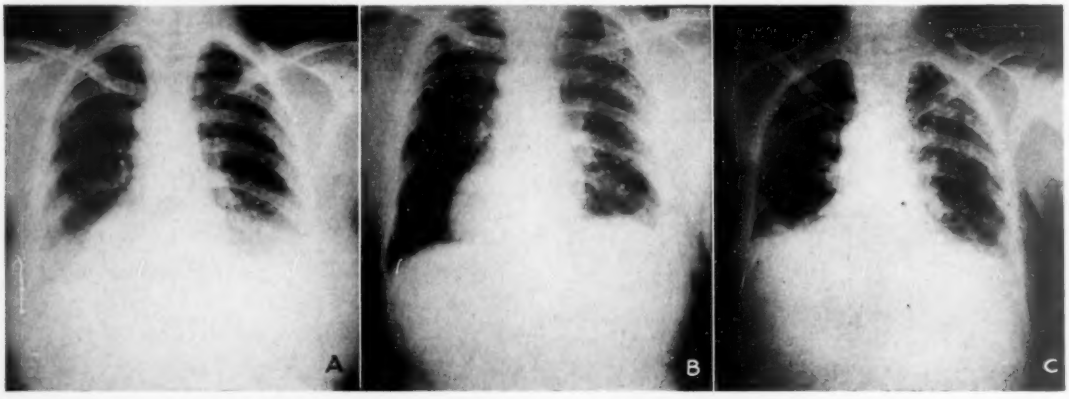

FIG. 6. Case XII. *A*. Before treatment. *B*. Four and two months after the first and second radon treatments respectively. *C*. Eight months after *B*, two months after the first course and near the conclusion of the second course of roentgen therapy.

dence of pleural thickening in the right lower axillary region and a mild increase of the lung markings in the right lung.

A course of roentgen therapy was given between August 22 and September 14, 1933, through three portals, each receiving 210 per cent S.E.D. Further roentgen examination of the chest on September 22, 1933, showed a slight increase of the changes previously seen, but on November 10, 1933, the pleural shadows were definitely less marked.

Another course of roentgen therapy was given between December 15 and 29, 1933, a fourth or axillary portal being added posteriorly. Each portal received 125 per cent S.E.D. A roentgen examination of the chest on December 28, 1933 (Fig. 6*C*), at a time when the last course of roentgen therapy was almost completed, revealed that the pleural shadow in both lower areas as well as the pulmonary markings was again increased, particularly on the left side, where there was a small effusion.

Comment. In Cases XI and XII the question of pneumonia and tuberculosis was considered in the differential diagnosis, but the clinical and laboratory data and the time relation between the appearance of the roentgen changes in the chest and the radiation therapy all led us to believe that the intrathoracic changes represented an irradiation reaction rather than the above-mentioned conditions.

Pleural effusion probably represents a reaction to acute changes in the pleura, such as have been observed by others in both clinical and experimental studies. The clearing of the thickened pleural shadow and disappearance of lung markings in Case XII about two months after the completion of the first course of roentgen therapy is interesting in that it seemed to indicate a subsidence of the reaction from the more acute congestive stage.

DISCUSSION

An attempt was not made to estimate quantitatively, as Desjardins did, the amount of irradiation required to effect a degree of pulmonary and pleural lesion sufficient to be noted in roentgenograms, although we may state that none of the cases in this series showed any reaction following 800 to 1,000 r of roentgen rays. An accurate estimation of the depth dose in radon therapy is difficult, because the areas treated and the depth of implantation vary widely not only in different patients but also in different regions in the same patient.

We are also unable to correlate the intensity of the irradiation and the extent of the subsequent changes produced in the lungs and pleurae. Theoretically, the extent of the lesion should vary directly with the intensity of the irradiation, but this may be influenced by the age and the difference in radiosensitivity of individual patients, and the technique of treatment. In general, the cases that received the most intensive radiation therapy showed the most marked changes.

That danger may be inherent in post-irradiation fibrosis of the lung and pleura has, thus far, not been determined. Wintz,[3] however, has suggested that an intercurrent infection such as bronchitis or pneumonia may be of very serious consequence if the areas of injured lungs become involved.

SUMMARY

1. Of 51 patients with extrathoracic tumors who received heavy irradiation directed to the thoracic wall and to the areas of the regional lymphatics, definite changes in the lung and pleura were observed roentgenologically in 12 instances.

2. These changes included pleural thickening, increased lung markings, contraction of the lung and shifting of the mediastinum.

3. The post-irradiation changes were believed to be due to a late fibrous tissue reaction following a more acute congestive change, and to be comparable to the irradiation reaction which may occur elsewhere in the body. Acute congestive reactions, as evidenced by pleural effusion soon after the irradiation, were observed in two cases.

4. Chronic pulmonary tuberculosis, in-

filtrative type of pulmonary metastasis and interstitial pneumonia were considered in the differential diagnosis. In all the cases in which definite changes occurred in the lungs and pleurae, as reported in this paper, signs, symptoms and laboratory evidence of the above diseases were not encountered.

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SPATIAL DISTRIBUTION OF RADIATION FROM A SUPERVOLTAGE ROENTGEN TUBE AND ITS SIGNIFICANCE IN THERAPY*

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ABSTRACT

IT HAS been known for some time that the initial intensity of hard radiation is not uniform in space around the target of a roentgen tube. From theoretical considerations, it can be shown that the short wave length part of the roentgen output reaches a maximum at a certain angle to the axis of the cathode ray, and that the maximum tends to move forward as the voltage is increased. Experimentally, a small effect was observed at lower voltages as early as 1909, and later was thoroughly investigated.

In the 500 kv. range we find that the maximum occurs at an angle of about 18° from the tube axis, and at this angle the intensity of heavily filtered radiation is of the order of three times the intensity at 90°. Furthermore, it can be shown that the ratio of these intensities for the hardest radiation, as the short wave limit is approached, becomes approximately 50 to 1. Hence, in order to make use of the hard radiation from a supervoltage tube, it is essential to take the beam out at a small angle to the tube axis. This effect will be greater at higher voltages.

These findings also serve to explain in part some of the anomalous results of filtration and depth dose experiments already reported.

INTRODUCTION

Roentgen rays are produced when high speed electrons of the cathode ray strike the target and give up their energy. However, very few electrons strike in such manner as to produce useful radiation. Most of the total energy given into the target is consumed in collision of a type producing only heat or long wave radiation which is subsequently removed by the filters. A very small percentage of the total electrons striking the target make some sort of direct collision with an atomic nucleus and give up all, or nearly all, of their energy in one burst. These electrons alone produce the useful part of the roentgen-ray spectrum. Further, very few of these electrons strike on or near the surface of the target and stop completely on their first collision. The target material consists of atomic nuclei, which can be considered tiny islands of matter in a sea of space partially filled with electrons, with the free space between the nuclei many times greater than their effective size. To take a concrete example: in the case of a high speed electron making a collision with a lead atom to produce a quantum of roentgen ray, the distance between is of the order of 25,000 times the effective size of the atomic nucleus upon which it must strike. It follows then that, on the average, a single electron impinging on the target may be slowed down or deflected in a number of ways. It may (*a*) make a slight glancing collision with a nucleus, giving rise to a quantum of soft radiation; (*b*) make an "elastic" collision with a nucleus, in which it is diverted from its original path without giving rise to radiation. In either of these cases the electron is left with most (or all) of its original energy, and it can then make further collisions with the target material, but at an angle different from its original direction. (*c*) The electron may make a primary direct collision with a nucleus and give up all of its energy at once. This case gives rise to the radiation at the short wave limit. (*d*) Of the electrons which give rise to useful radiation, the case occurring most frequently is that in which the electron makes a collision with a nucleus and gives

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up simply a large part, but not all, of its energy at once. This event may take place with a primary electron, or with an electron yielded by case (*a*), or (*b*), making a secondary collision. These events may occur in different sequences, and in any case where the electron has not lost all of its energy it may go on to subsequent secondary, tertiary and higher order nuclear collisions in which some radiation may be produced. Of all possible events occurring to a cathode electron impinging on the target the most probable is (*e*) that the electron will simply penetrate to some depth in the target material without colliding with a nucleus and will set in motion a large number of atomic electrons, losing energy gradually and unproductively. A negligible few of these agitated electrons may acquire sufficient energy to produce radiation by secondary collisions with nuclei, but the vast mass of them gain energies equivalent to only a few volts, and this energy eventually is dissipated as heat. There are also other possible collision processes which may give rise to radiation, but the probability of occurrence of any of these events is so low that they may be neglected. From these considerations it is easily seen why, in the 500 kv. range not more than 3 per cent of the total energy fed into the roentgen tube can be made available in the form of radiation. The percentage is of course less with increasing filtration. In the 200 kv. range, not more than one-half of 1 per cent of the input energy emerges as roentgen rays.

For practical purposes, as in therapy, it was always assumed that the primary radiation emitted from a target came off in all directions with equal intensity. It has been known for a long time, however, that this was not strictly true. As early as 1909 Kaye[1] and Stark[2] showed that there was a measurable increase in intensity in the forward direction over the intensity at 90° or greater angles from the axis of the cathode ray. In the same work Stark noticed that the absorption coefficient for the radiation was smaller in the forward direction than at large angles, showing that even in the low voltage range then available, the quality of the radiation improved with a decrease in angle. A complete historical résumé of this experimental work will be found in the work of Compton and Allison.[6]

This work, while of great theoretical importance, had little practical significance for several reasons. The voltage was too low and the filtration in practical use too little to bring out the effect. In addition, all of the tubes in practical use had thick targets, usually backed by a cooling system, and were not in any sense transparent to the primary radiation. As will be noted in the history referred to above, the effect could only be noticed in tubes having very thin targets, in which secondary electron collisions were negligible and the filtration of the target not too heavy. In 1929, the great theoretical physicist Sommerfeld gave an explanation of this phenomenon. Since that time he and his students have evolved a complete mathematical theory which predicts the emission of roentgen radiation in all of its details in quantitative manner. This theory in its final form is based on the newer concepts of the quantum mechanics developed since 1925, and predicts accurately both the angular distribution and the increased hardness of the radiation in the forward direction.

With the advent of supervoltage tubes, this situation in the field of practical roentgenology was changed somewhat. It was soon noticed that with non-transparent targets the radiation emitted at 90° to the tube axis did not quite reach the quality that might have been predicted for it. Further, the relatively large penetration of the cathode electrons into the target material made it possible to build a target of practical dimensions which would approach the qualities of a "thin" target for the first time. In addition the use of these high voltages made the use of a transparent target practical. No practical target can be constructed which has all of the qualities of the thin target of the theoretical physicist, as this concept involves a target so

thin that the cathode electrons in passing through can make only primary collisions. This would mean practically a target consisting of a single layer of atoms. The thinnest targets so far put into practical use, however, are equivalent in thickness to about twice the normal range of penetration of the electrons into the target material. This then gives a few primary collisions at all depths within the material, even to the very back of the target, although naturally the primary collisions occurring on or near the back are insignificant in number compared to those occurring near the face. The important advantages gained by the high voltage and the transparent target are that it is possible to take a beam out and make measurements at nearly all angles, and that the amount of radiation produced is so great that heavy filters may be used. It is worthy of note that due to the penetration of the primary electrons into the material (usually lead) of the transparent target, the primary radiation produced and measured without the addition of any filter shows practically the same "filtration" whether taken off through the body of the focal spot or from the face of it.

Within the past few years the existence of the supervoltage therapy tubes has made possible the extension of this experimental work into the higher voltages. Such a tube has been in operation and available at Harper Hospital since 1932. This tube operates on a constant potential, has end ground construction with the target projecting in a horizontal plane well clear of the floor, walls, and other obstructions, and has a transparent target consisting of 0.004 in. of lead backed with thin copper. Hence it combines all of the needed advantages for this type of experimental work, with the exception that it is not possible to make measurements at angles close to 180° from the direction of the cathode beam. The tube normally operates on a constant voltage of 500 kv., at which voltage it is to be expected, on the basis of theory, that the asymmetry of the filtered beam, both as to spatial distribution and quality, would be quite marked.

EXPERIMENTAL

In normal operation the target and the part of the body of the supervoltage tube which projects into the treatment room is completely encased in lead. Two cones for the beams used in treatment project from the lead armor around the target and extend vertically upward and downward to the treatment couches. The details of this arrangement have already been published.[3] For the work under consideration the lead armor was removed. In order to keep control of the tube output in the usual manner, it was necessary to up-end the lower treatment cone which contains a control ionization chamber, and place it on a small table where it was fully exposed to the radiation from the target, and left unmoved throughout the course of the experiments. In this way the usual galvanometer instrument in the control room could be used for keeping the output constant. Two Victoreen thimble chambers were used for the actual measurements. Both of these chambers were encased in lead bombs which were of uniform wall thickness and had one solid end. The open ends through which the chambers were slipped in and out were closed with a large plug of solid lead which was machined to fit and had a one-half inch shoulder. In this way the chamber was protected from all unwanted radiation. At a point directly over the thimble chamber, near the solid end of the bomb, the lead was thinned down to the thickness desired for filtration. One chamber was placed on a table at a distance of 60 cm. from the focal spot and directly below the target of the tube. The lead container for this chamber was not moved during the course of the experiments. In this way an integrated reading of the total output during the time of each exposure was obtained, and this reading could be used to correct for slight variations in the tube output. The container for the chamber used in taking the measurements at different angles was mounted on a ring stand which was placed on a stepladder. A cord was fastened securely to the end of the roentgen tube exactly over the center of the focal

spot. This cord was then extended across the room in a precise extension of the axis of the cathode beam and fastened to the far wall with adhesive tape. A second cord fastened over the focal spot was left free and marked accurately at 60 and 120 cm. of its length from the target. This cord was then used to keep the center of the ionization chamber at constant distance from the focal spot as the angle was changed.

The experimental measurements were then made in the following manner: With the reference thimble chamber in place in its lead shield below the tube, the measuring chamber was placed in its lead container on the ring stand. The stand was then moved to any desired position in the room. The center of the ionization chamber was kept at constant distance from the focal spot by measuring with the marked string and the angle determined by measuring the straight-line distance from the center of the chamber to the cord which marked the axis of the cathode ray. This distance in centimeters divided by 60 was then the sine of the angle. To save time in setting up, a protractor was drawn out on a large sheet of cardboard, and the distance from chamber to string to give each of the desired angles was calculated in advance. The chamber was then set approximately with the protractor and finally set precisely by measuring the distance. When these factors were correctly adjusted the tube was started and kept in operation for whatever length of time was required to give a reliably large reading on the scale of the Victoreen meter. With the distance at 60 cm. and 6 mm. lead filtration the time was ten minutes, and this time was kept constant throughout the series of measurements made under these conditions. For most of the readings taken the tube factors were: 500 kv. constant potential, 3 ma. tube current. One complete set of readings was run at 400 kv. The distances used have been given and the filtration for any set is marked on the curves. Readings were taken at 5° intervals near the forward direction and at 10° intervals in the directions nearer 90° where the variation between intervals was smaller. In taking any one reading on the measuring chamber, the normal operating variation of the tube had to be taken into account, which was done by correcting the reading found against the reading on the fixed control chamber. When a complete series had been run, the readings were all reduced to percentages of the maximum and a curve drawn.

Among the sources of error to be noted are: (1) The angular aberration due to the size of the focal spot. The diameter of the focal spot was about 3 cm., which at 60 cm. distance subtends an angle of less than 3° of arc. (2) The actual size of the ionization chamber, which subtended an angle of about 1° of arc. (3) The accuracy with which the Victoreen meter could be read. The readings were taken to one-tenth of a scale division which would give an error up to ±2 per cent. However the same operator made all of the readings in a given series and read to the same side of the line in all cases. Many of the readings were checked by two operators. (4) Errors in the measuring instrument itself. The readings are not necessarily in roentgens and are comparable only with themselves. During exposure the thimble chamber was tightly enclosed in the lead bomb which was thick enough so that all stray and scattered radiation could be neglected. The bomb was lined with an immovable tube of thin steel. The wave length change to be expected after filtration through a minimum of 6 mm. of lead is too small to be considered as causing a wave length dependence on the sensitivity of the meter. The inherent accuracy of the meter for this particular problem is therefore probably much better than the 5 per cent allowance made for ordinary use. (5) Personal errors: (*a*) due to the long distances used, the measurement of angles in setting up the apparatus was accurate to less than half a degree; (*b*) errors in reading have already been covered; (*c*) arithmetical errors in getting the ratio between the measuring chamber and the control chamber were confined to insignificant figures which were dropped as usual. About two hundred

readings were taken altogether, and all important readings were checked repeatedly. As a graphical check of accuracy, it may be noted that in making the final set of readings after the technique had been established, none of the readings fell more than ±1 per cent off of the smooth curve representing all of the readings. However, a fundamental accuracy of better than ±5 per cent is not claimed.

Figure 1 is a photograph of the tube and measuring apparatus in use. Figure 2 is a

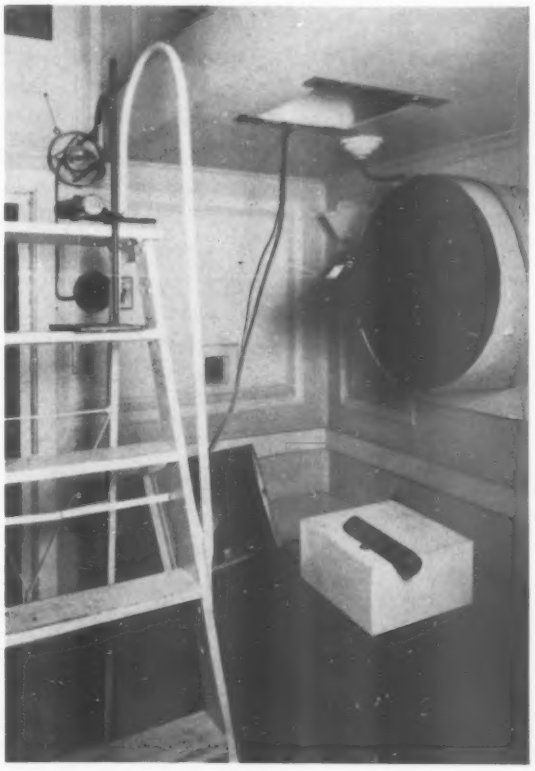

Fig. 1

phantom drawing taken from the photograph showing the position of the cathode and target of the roentgen tube, the extension of the cathode-ray axis, and the various quadrants through which the ionization chamber was moved in making the measurements. The edge of the upper treatment couch formed an obstruction which cut out the 80° angle from the measurements taken in the upper quadrant. The welds in the target body formed obstructions in the other three forward quadrants

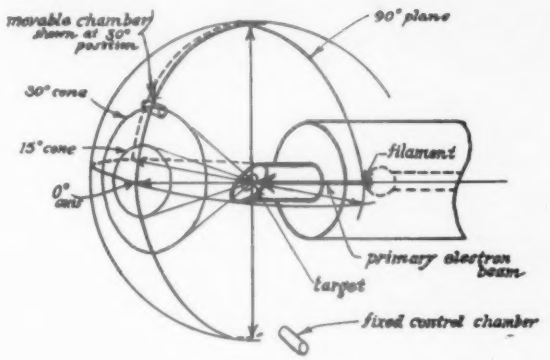

Fig. 2

but covered such small angles that they were not serious. Each angle obstructed in any one quadrant could be obtained on two or more other quadrants. The highest angle obtainable was 153°, and at this point it was necessary to correct for the change in the distance necessary to avoid the body of the tube, and for the increased effective thickness of the iron, both of which corrections could be applied easily.

Figure 3 is a polar plot showing the experimental results of the investigation. It is seen at once that 12 mm. of lead took out appreciably more of the low grade radiation than did 6 mm., as is to be expected. Consequently, the intensities at angles greater than 45° are considerably reduced. At 400 kv. the effect of 6 mm. of lead is of course greater than at 500 kv., consequently the 400 kv. curve approximates the shape of the curve for the higher voltage and heavier filtration, except for the fact that it has its own characteristic maximum at about 25° instead of 18°. Since all of these curves are plotted on a

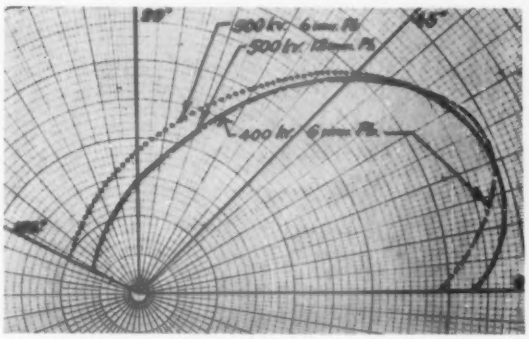

Fig. 3

percentage basis, they are all brought to the same value for the maximum, so that the absolute values are not shown. The intensity at 90° on the curve for the heaviest filtration at 500 kv. is shown to be about one-third of the intensity at the

$$I = \frac{2e^4Z^2}{R^2m^2C^4}\frac{p}{p_0^3}\left\{\frac{(3E^2-p_0^2)\sin^2\theta}{E_0^4u^4} - \frac{2E^2-p_0^2}{E_0^2u^2} - \frac{Ep_0\cos\theta}{2E_0^3u^4}\right.$$
$$- \frac{p_0^2}{2pE_0u}\log\frac{E+p}{E-p} + \frac{p_0^2(\alpha\cos\theta-p_0)}{2Q_0^2E_0^2u^2}$$
$$+\left(\frac{1}{2E_0^2u^2} - \frac{\alpha}{E_0u} + \frac{\alpha^2(\alpha-p_0\cos\theta)}{2Q_0^2E_0^2u}\right)\frac{p_0^2}{pQ_0}\log\frac{Q_0+p}{Q_0-p}$$
$$+\log\frac{E_0E-1+p_0p}{E_0E-1-p_0p}\left[\frac{(2E_0\alpha-E_0E_p^2)\sin\theta}{2p_0pE_0^4u^4} + \frac{3E_0^2p_0^2-4E_0\alpha+p_0^2p^2}{4p_0pE_0^3u^2}\right.$$
$$\left.\left. - \frac{(E_0E+p_0^2)\alpha\cos\theta}{4pE_0^3u^2}\right]\right\}$$

FIG. 4. I = Intensity of radiation on cone of half angle θ. e = Charge of electron = 4.77×10^{-10}. m = Mass of electron = $9.\times10^{-28}$. C = Velocity of light = $3.\times10^{10}$. Z = Atomic number of target material. R = Distance from target. $E_0 = 1 + 1/mC^2\times$ kinetic energy of impacting electron. $E = 1 + 1/mC^2\times$ kinetic energy of scattered electron. $p_0 = 1/mC\times$momentum of impacting electron = $\sqrt{E_0^2-1}$. $p = 1/mC\times$momentum of scattered electron = $\sqrt{E^2-1}$. $\alpha = 1/mC^2\times$energy of emitted quantum of radiation. $u = 1-\beta_0\cos\theta$. $\beta_0 = 1/C\times$velocity of impacting electron = $\sqrt{1-(1/E_0^2)}$. $Q_0 = \sqrt{p_0^2-2p_0\alpha\cos\theta+\alpha^2}$. $Q = \sqrt{p^2-2p\alpha\cos\theta+\alpha^2}$.

maximum. Further, it will be noted that the curves for the 6 mm. and 12 mm. lead filter at 500 kv. are identical between 0° and about 27° but very different at higher angles. This demonstrates the great difference in quality of the original beam between these angular ranges. In the forward direction, 6 mm. of lead is enough to bring the beam into approximately true physical equilibrium, while at 90° a measurable portion of the lower grade radiation still persists at this filtration.

THEORETICAL

It is of great interest to interpret the experimental data by means of the formulas derived theoretically from the quantum mechanics by Sauter.[4] These formulas are derived from principles that have been found to have a very wide range of application, giving correct and precise results in all of them. The formulas are apparently rather complex, but except for the large amount of numerical work involved they can be used for the direct computation of the intensity of radiation of any wave length produced at any angle relative to the direction of the electron beam striking an ideally "thin" target. For a high atomic number target, such as lead, the formulas are not strictly applicable, especially for radiation near the short wave limit, but it can be shown that the relative intensities at various angles will still be given quite accurately. The older formulas given by Sommerfeld[5] are not valid in the 500 kv. range, but Sauter's formulas are valid for all voltages which are considerably higher than the characteristic excitation voltage for the element of the target. Figure 4 shows the formulas used in the present calculations. Its derivation is given in Sauter's paper but it is here shown in a simplified notation. Figure 5 is a composite drawing of the experimental data at 500 kv. and the theoretical results, drawn to the same scale as before. Curve A of Figure 5 shows the relative intensities of 0.031Å

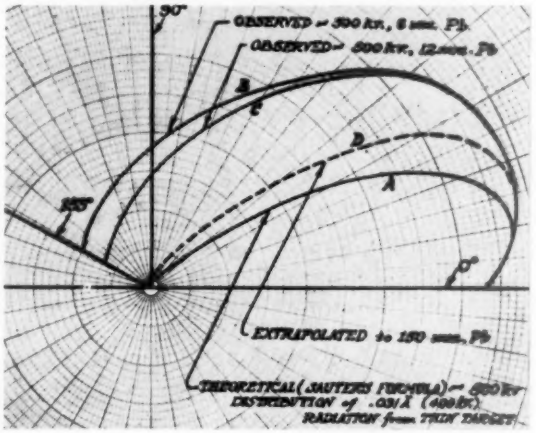

FIG. 5

(400 kv.) radiation produced from a thin target by 500 kv. electrons, as computed from the formulas shown in Figure 4. Further computations have shown that the general shape of the polar curve does not change much for any of the wave lengths produced by 500 kv. electrons that will get through heavy lead filtration. It will be

noted that the intensity at right angles to the electron beam is less than 2 per cent of that at the maximum, and the intensity at 0° is less than that at the maximum, which occurs at about 10°. The actual target used in the experimental work is not "thin" in the sense that secondary high speed electrons cannot make collisions in the target. In fact, the observed radiation is a summation of that produced by primary, secondary and higher order electrons. The secondary and higher order electrons will, on the whole, be deflected from the direction of the primary electrons, and will have lost some energy. The radiation they produce will then have a greater proportion of intensity at right angles to the electrons' direction, and as this latter direction is at an angle to the direction of the primary electron beam, the contribution to the intensity at right angles to the beam axis can be considerable. This contribution to the summation is not on the average of as high a quality as that due to the primary collisions, as most of the deflected electrons have lost some energy. This state of affairs is in complete agreement with the experimentally observed intensity distribution shown in Curves *B* and *C* of Figure 5. As these curves have been adjusted to make the maximum the same, they are really polar plots of $I / I_{\max}$ Curve *B* is that of $I_{.6} / I_{.6\,\max}$, *C* that of $I_{1.2} / I_{1.2_{\max}}$. If μ is the average absorption coefficient of the radiation in lead (μ depends on the angle), then

$$I_{1.2}=I_{.6}e^{-\mu\cdot 6} \text{ and } I_{1.2\max}=I_{.6\max}e^{-\mu_{\max}6}.$$

Therefore:

$$\frac{I_{1.2}}{I_{1.2\max}} = \frac{I_{.6}}{I_{.6\max}}\, e^{-(\mu-\mu_{\max})\cdot 6}$$

In other words, $\mu-\mu_{\max}$ is the apparent absorption coefficient in going from Curve *B* to Curve *C*. This shows that the actual absorption coefficient becomes progressively greater at large angles so that, for example, the quality of radiation at 90° is much worse that at 0°. From these two curves we can extrapolate to the expected distribution curve for larger amounts of lead filtration than those used experimentally, by the formula

$$\frac{I_d}{I_{d\max}} = \frac{I_{.6}}{I_{.6\,\max}}\left(\frac{I_{1.2}}{I_{1.2\max}}\cdot\frac{I_{.6\max}}{I_{.6}}\right)^{d/.6-1}.$$

By using a heavier and heavier filter, the softer radiation is preferentially decreased so that the extrapolation of the experimental distribution curve to the larger amounts of filter ought to approach the theoretical primary radiation distribution. This extrapolation cannot be done with more than the original experimental accuracy but Curve *D* of Figure 5 shows the results obtained by extrapolation to 150 mm. of lead. It is seen that the result is very reasonable and confirms the application of the theory to the experiments. The direct measurements with lead filtration only give about one-third the intensity at 90° as at the maximum, and it is clear that the quality at 90° is much poorer than that in the forward direction. From the theory we conclude that the very hardest part of the spectrum is obtained in a negligible amount at 90° compared to that obtained at small angles. It is striking that a minimum occurs at 0° experimentally in about the same ratio to the maximum as that predicted theoretically for the hardest primary radiation.

DISCUSSION OF RESULTS

The filters used in these experiments were of course for analytical purposes only, and it is not proposed that such filtration should be used for practical therapy in this voltage range. The analysis was undertaken for two specific purposes: (1) to check the theoretical distribution of intensities, and (2) to find out, if possible, why certain inexplicable results have been shown in depth dose and other practical measurements in this voltage range. Both purposes have been served to some extent, although the work on the second must be continued. In all probability, further increases in voltage will greatly enhance this effect, and from data now available we are led to believe that at higher voltages even

more of the desirable end of the spectrum is distributed down the axis of the tube, so that at 1,000,000 volts or more the radiation at 90° to the tube axis is not nearly so far superior to that at lower voltages as it should be, and as it really would be if the radiation could be taken out at the maximum. This effect is undoubtedly of sufficient importance so that it must be considered in the design of higher voltage tubes.

The demonstration of the fact that a very large portion of the radiation emitted by a roentgen tube at high voltage is due to secondary nuclear collisions of the cathode electrons, and that many of these electrons are deflected through a considerable angle with only minor loss of energy, is not unexpected. It is interesting that these experiments shed some light on anomalous results already found in filtration experiments in this voltage range. With practical filters, the beam (at 90°) is quickly brought to equilibrium at some relatively low equivalent voltage, after which no reasonable addition of filter will make a practical improvement in the quality commensurate with the loss in radiation intensity. The explanation seems to be that the required proportion of the hardest end of the spectrum, for obtaining an expected equivalent voltage, is simply not present. From this naturally follows some tentative explanation of the fact that physicians have reported the erythema dose in this range only slightly increased by very heavy filtration. The practical net effect is that only small gains in depth dose and increased erythema dose have been obtained in most supervoltage installations so far constructed, and that it is to be expected from physical considerations that superior results will be obtained by the use of portals placed in a suitable position to receive the best quality radiation from the target. Much work must be done to show the practical significance of this expectation.

SUMMARY

It has been shown:

(1) That the radiation emitted by a high voltage tube in that part of its spectrum near the short wave limit reaches a maximum of intensity at some angle in the forward direction with respect to the cathode ray.

(2) That this angle of maximum intensity is characteristic of the voltage and varies with the voltage.

(3) That a very small portion of the hardest radiation is emitted at large angles, most of it being projected near the maximum.

(4) That this projection of the highest intensity of the hard radiation forms a cone around the geometric projection of the axis of the cathode ray, the most intense part of the beam lying close to the cone of the maximum angle, and the intensity falling away both toward the larger angles and toward the zero axis.

(5) That the theoretical calculations agree with the experimental findings in this voltage range.

(6) That the intensity of the radiation of the short wave limit through a portal at 90° to the axis of the roentgen tube is about 2 per cent of the intensity of the same radiation at the angle of maximum intensity.

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Twenty-second Annual Meeting: Hotel Chelsea, Atlantic City, N. J., June 7–8, 1937.

EDITORIAL

RENAL RICKETS

IT HAS been a little over seventeen years since Barber[1] employed the term renal rickets to designate a group of cases exhibiting stunted or deformed growth and chronic renal disease. Since Barber's paper there have been from time to time reports of additional cases of bone changes associated with chronic renal disease of the type occurring in Barber's cases. Whether the term "renal rickets" is an appropriate one or not, the fact remains that the skeletal changes observed in these unfortunate individuals in association with renal disease has become a more or less distinct clinical entity since Barber's clear cut description. Long before Barber's description, Lucas,[2] in 1883, reported a number of cases of rickets associated with albuminuria in late childhood and used the term "rickets of adolescence" to describe them, and Price and Davie,[3] in a recent report, credit Fletcher with more clearly defining the clinical entity known today as renal rickets. Certain it is that with a more widespread use and improved roentgenographic technique in connection with biochemical analysis, many of the obscure abnormalities of bone development and growth disturbances have been more clearly defined and elucidated.

While the condition known as renal rickets is supposedly a relatively rare one, the recurring reports in the literature would lead one to believe that probably it is a more common disease than is generally believed, and no doubt the skeletal manifestations as observed roentgenographically are sometimes confusing and a correct diagnosis is sometimes delayed. The typical rachitic changes observed in infancy and early childhood are too well known to warrant comment, but there remains a group of cases in which skeletal changes of a rachitic nature appear during later childhood or adolescence which present some difficulty in diagnosis to both the clinician and the roentgenologist.

The clinical manifestations of renal rickets are fairly typical. The early symptoms usually occur about the age of seven and consist of polyuria and polydipsia associated with retardation of growth, though the characteristic bone changes are observed in later childhood or may indeed be delayed until after puberty; not infrequently it is the bony skeletal deformities which cause the child to be brought under medical observation, this in spite of the fact that close questioning may elicit the information that the child has suffered from some pain which may be associated with renal calculi or disturbance in renal function.

The earlier skeletal changes are manifested frequently in the rapid development of genu valgum between the ages of ten and fifteen years, and this deformity occurring in a stunted child with a history of thirst and polyuria should always suggest the possibility or even the probability of renal rickets. In spite of the rather marked skeletal deformities the majority of cases, Price and Davie state, show little, if any, mental defect, but do frequently show delayed sex development; the skin shows a characteristic sallow or earthy tinge, the hair is sparse and dry, and a hypochromic anemia is the rule. The urine is usually copious and of low specific gravity. The kidneys are incapable of excreting a concentrated urine. Renal function tests demonstrate gross inadequacy and most cases terminate in uremia.

[1] Barber. Quoted by Price and Davie.
[2] Lucas. Quoted by Price and Davie.
[3] Price, N. L., and Davie, T. B., Renal rickets. *Brit. J. Surg.*, January, 1937, *24*, 548–569.

The roentgen appearances of the skeletal changes are recognizable in two distinct types: a so-called Type A in which the shafts of the long bones retain a reasonably normal density, but more or less florid rachitic changes are seen at the extremities differing in no essential detail from those seen in ordinary rickets. There is no bending of the shafts, but simple displacement of the epiphyses is liable to occur. It is in this type that possible healing may take place, provided the condition is recognized and proper therapy instituted. The second, or so-called Type B, is quite unlike the picture associated with ordinary rickets. The bones show a generalized osteoporosis with a loss of demarcation between cortex and medulla. The "cupped metaphysis" is both broader and deeper than normal, and shows a ground glass, woolly, or motheaten appearance with varying degrees of stippling; not infrequently there is an appearance of subperiosteal erosion extending for a short distance along the diaphysis, and the vault of the skull shows considerable thickening. The changes exhibited in the skeleton are not unlike those seen in cases of multiple osteitis fibrosa and the more severe deformities of renal rickets are found in this type of skeletal change. The gross deformities which are observable are due to a collapse of the softened metaphysis with a resultant rotation of the epiphysis, and secondary epiphyseal displacements occur which add considerably to the deformity.

These extreme skeletal changes observed roentgenographically in Type B, as Price and Davie say, are probably to be correlated with parathyroid overactivity, as parathyroid enlargement is found in many advanced cases of the disease, and in these the striking resemblance of the skeletal changes to hyperparathyroidism is too evident to be ignored.

The etiological factor which brings about these profound changes observed in the skeleton and in the kidneys of these cases is not clearly defined. There are those investigators who believe that the primary change occurs in the kidneys, that as a result of chronic renal disease in childhood the skeletal changes are brought about and that the primary changes are caused by the inability of the damaged kidney to effect an adequate excretion of phosphates. Certain it is, as has been pointed out many times, but especially by Parsons,[4] that by reason of the raised value of blood phosphates a relative, if not an actual, deficiency of blood calcium follows and this relative calcium deficiency interferes with the deposition of bone, resulting in an endogenous form of rickets. The kidneys of these patients show at autopsy chronic interstitial nephritis or nephroscerosis but occasionally cases have been reported in which polycystic kidneys, pyelonephritis and defective kidney development have been observed, and some cases have been reported in which there was definite ureteric dilatations resulting from congenital valves at the ureteric orifices.

Some investigators have advanced the idea that the primary disturbance is in an overactivity of the parathyroid glands associated with some pituitary dysfunction, but not all of the cases coming to autopsy exhibiting the marked skeletal changes have shown parathyroid adenoma, and another objection to the endocrine theory is provided by the group of cases in which the renal damage is associated with congenital abnormalities of the urinary tract.

Price and Davie conclude from an analysis of their cases and from the literature that "the only possible definition of renal rickets at the present stage of our knowledge is one which makes no mention of etiology, but merely expresses the relationship of the principal features, e.g., 'a disease of childhood characterized by skeletal demineralization with resultant deformities, and associated with chronic renal disease which in uncomplicated cases terminates in uraemia.' " With the acceptance of such a definition it is, as they say, clearly appreciated that the diagnosis of renal rickets is *not* made until both skeletal

[4] Parsons. Quoted by Price and Davie.

and advanced renal changes are present. It appears probable that the clinical condition diagnosable as renal rickets may be, not a disease entity of itself, but a syndrome common to either of two separate and distinct diseases in their late stages." That the disease is not an uncommon one is clearly indicated by the occurrence of case reports from time to time in the literature, and since the etiology of the disease is still a debatable factor, all the cases coming under observation with complete studies should be reported in the hope that an accumulation of data may lead to a more thorough understanding of a somewhat obscure syndrome.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa. Annual Meeting: Chicago, Ill., Sept. 13–17, 1937.

American College of Radiology
Secretary, Dr. E. L. Jenkinson, 1439 S. Michigan Ave., Chicago, Ill. Annual meeting: Chicago, Ill., September, 1937.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: Atlantic City, N. J., June 9–11, 1937.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N.Y. Annual meeting: Chicago, Ill., Sept. 13–17, 1937.

Radiological Section, Baltimore City Medical Society
Secretary, Dr. Howard H. Ashbury, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut State Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets annually in May. Special meetings may be called by the Chairman.

Radiological Section, Los Angeles County Medical Society
Secretary, E. N. Liljedahl, Los Angeles, Calif. Meets on the second Wednesday of each month at the County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. E. Mendelson, 120 E. 19th St., Brooklyn, N. Y. Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. R. G. Willy, 1138 N. Leavitt. Meets second Thursday of each month October to May inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. H. G. Reineke, General Hospital Cincinnati, Ohio. Meets third Monday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. North W. Shetter, 14600 Detroit Ave. Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Denver Radiological Club
Secretary, Dr. N. B. Newcomer, 306 Republic Bldg., Denver, Colo.
Meets on the third Tuesday of each month.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Florida State Radiological Society
Secretary, Dr. Harold O. Brown, Tampa, Florida. Meetings held twice a year, May and November.

Illinois Radiological Society
Secretary, Dr. Cesare Gianturco, 602 W. University Ave., Urbana, Ill. Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. C. C. Taylor, Indianapolis, Ind. Meeting held the second Sunday in May annually.

Long Island Radiological Society
Secretary, Dr. S. G. Schenck, 115 Eastern Parkway, Brooklyn, N.Y. Meets at Kings County Med. Soc. Bldg. on third Thursday of each month from October to May, at 8:30 P.M.

Michigan Association of Roentgenologists
Secretary, Dr. C. S. Davenport, St. Lawrence Hospital, Lansing, Mich. Three meetings a year, Fall, Winter, and Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. S. A. Morton, Columbia Hospital, Milwaukee, Wis. Meets monthly. Place of meeting named by the president.

Minnesota Radiological Society
Secretary, Dr. H. M. Weber, Mayo Clinic, Rochester, Minn.

Nebraska State Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets third Wednesday evening of each month.

New England Roentgen Ray Society
Secretary, Dr. E. C. Vogt, 300 Longwood Ave., Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. P. S. Avery, New Brunswick, N. J. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by the president.

New York Roentgen Society
Secretary, Dr. R. W. Lewis, 140 E. 54th St., New York. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse, N. Y. Three meetings a year—January, May, and November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, Williamsport, Pa. Two day annual meeting will be held Friday and Saturday, May 21 and 22, 1937, Hotel Lawrence, Erie, Pa.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave. Meets on second Thursday from October to May, inclusive, 8 P.M., Rochester Academy of Medicine Building.

St. Louis Roentgen Ray Society
Secretary, Dr. P. C. Schnoebelen, Missouri Bldg., St. Louis, Mo. Meets first week of each month. Time and place of meetings designated by president.

South Carolina X-Ray Society
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston. Meets at time and place of South Carolina State Medical Association.

Tennessee Radiological Society
Secretary, Dr. T. B. Bogart, 311 Medical Arts Bldg.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. M. H. Glover, 414 Hamilton Bldg., Wichita Falls, Texas. Meets twice a year.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Secretary, Dr. C. B. Peirce, University Hospital, Ann Arbor, Mich. Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. F. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. V. W. Archer, University Hospital, University, Va.
Meets annually in October.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1, or as advertised.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine, 1, Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to Nov. incl. for scientific discussions.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. C. Singleton, Medical Arts Bldg., Toronto 5, Ontario.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIEDAD ESPAÑOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, 11.52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banul Măräcine, 30, S. I., Bucuresti, Roumania.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson, Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime.

SOCIETY OF MEDICAL RADIOLOGY IN SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA ROENTGEN SOCIETY
Meets first Wednesday of each month, at 6.30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto Japan. Meets bi-monthly on third Sunday.

MINNESOTA RADIOLOGICAL SOCIETY

The annual meeting of the Minnesota Radiological Society was held in St. Paul, Minnesota, in connection with the meeting of the Minnesota State Medical Society. The annual Carman Lecture was delivered to the general assembly of the Minnesota State Medical Association by Dr. Edward H. Skinner of Kansas City on "Reflections on the Roentgenology of Fractures."

Dr. Skinnner also addressed the Minnesota Radiological Society on the subject "Comments upon Early Books upon Electricity and the Roentgen Ray."

Dr. Robert S. Stone of San Francisco delivered the annual Christian Lecture on Cancer before the State Medical Society. His subject was "Irradiation Therapy of Tumors with a Consideration of the Possibilities of Supervoltage X-rays." He also addressed the Minnesota Radiological Society on "The Professional and Economic Status of the Radiologist."

Officers for the coming year were elected as follows: President, Dr. Walter H. Ude, Minneapolis; Vice-President, Dr. Leo G. Rigler, Minneapolis; Secretary-Treasurer, Dr. Harry M. Weber, Rochester.

MIDSUMMER RADIOLOGICAL CONFERENCE

The following is a preliminary program of the Midsummer Radiological Conference in the Rocky Mountains to be held at the Hotel Shirley-Savoy, Denver, on July 15, 16 and 17, 1937.

Thursday, July 15

2:15 p.m.—W. W. Wasson, M.D., Presiding, President, Denver Radiological Club
Address of Welcome, A. J. Markley, President, Colorado State Medical Society, Denever

2:30 p.m.—Symposium on the Breast
Anatomy of the Breast, H. C. Tracy, M.D., University of Kansas, Lawence, Kansas
Pathology of the Breast, Frederick C. Narr, M.D., Pathologist, Research Hospital, Kansas City, Mo.
The Roentgen Examination of the Breast, Ira H. Lockwood, M.D., Kansas City, Mo.
Benign Lesions of the Breast, James E. Stowers, M.D., Kansas City, Mo.
The Surgical Treatment of Carcinoma of the Breast, Claude J. Hunt, M.D., Kansas City, Mo.
The Radiation Treatment of Carcinoma of the Breast, Lewis G. Allen, M.D., University of Kansas, Kansas City, Kan.

4:30 p.m.—Discussion opened by Henry Schmitz, M.D., Chicago

8:00 p.m.—Joint meeting with the Medical Society of the City and County of Denver, Paul J. Connor, M.D., Presiding, President of the Medical Society of the City and County of Denver
Guest Speakers: Leo G. Rigler, M.D., Minneapolis, Minn., *The Roentgen Examination in Preventive Medicine;* Henry Schmitz, M.D., Chicago, *The Selection of the Form of Treatment in Uterine Myomas.*
General Discussion

Dutch Lunch in Rathskeller
Courtesy Denver Radiological Club

Friday, July 16

9:30 a.m.—*Recent Advances in Diagnostic Radiology*, Ernest A. Schmidt, M.D., Denver

10:00 a.m.—*Roentgen Ray Pelvimetry and Cephalometry*, Paul C. Hodges, M.D., Chicago

10:45 a.m.—*Roentgen Findings in Pleural Effusions*, Leo G. Rigler, M.D., Minneapolis

11:30 a.p.—*Roentgenologic Studies of the Gastro-Intestinal Motor Phenomena*, Leon J. Menville, M.D., New Orleans

12:30 p.m. to 2:30 p.m.—*Luncheon, Round Table Discussion of the Problems of Diagnostic Radiology*, Chairman—Frederick E. Diemer, M.D., Denver

2:45 p.m.—*The Demonstration of the Crater in Duodenal Ulcer*, Paul C. Hodges, M.D., Chicago

3:30 p.m.—*Bone Tumors*, Leon J. Menville, M.D., New Orleans

4:15 p.m.—Adjournment

6:15 p.m.—Cocktail Hour

7:00 p.m.—Informal Banquet, Venetian Gardens; W. W. Wasson, M.D., Presiding, President, Denver Radiological Club

Saturday, July 17

9:00 a.m.—*Recent Advances in Radiation Therapy*, Paul R. Weeks, M.D., Denver

9:30 a.m.—*The Diagnosis, Treatment and Curability of Intraoral Cancer*, Hayes E. Martin, M.D., New York

10:45 a.m.—*The Diagnosis and Treatment of Cancer of the Uterus*, Henry Schmitz, M.D., Chicago

12:00 noon—Adjournment

12:30 p.m. to 2:30 p.m.—Luncheon, Round Table Discussion of Therapeutic Radiology, Sanford Withers, M.D., Presiding, Denver.

BOOK REVIEWS

Books received are acknowledged under heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

ERGEBNISSE DER MEDIZINISCHEN STRAHLENFORSCHUNG (RÖNTGENDIAGNOSTIK, RÖNTGEN-, RADIUM- UND LICHTTHERAPIE). (Advances in Medical Radiology, Roentgen Diagnosis, Roentgen, Radium and Light Therapy.) Volume VII, Edited by H. Holfelder, Frankfurt a. M.; H. Holthusen, Hamburg; O. Jüngling, Stuttgart; H. Martius, Göttingen, and H. R. Schinz, Zürich. Paper, price 67.50 Marks; bound 69.50 Marks. Pp. 622, with 294 illustrations. Leipzig: Georg Thieme, 1936.

The seventh volume of this well-known publication offers again a series of monographs dealing with diagnostic and therapeutic problems in radiology.

The right-sided aorta is the topic assigned to B. Kommerell. He discusses in detail the embryological background of this anomaly which was first recognized roentgenologically intra vitam by Assmann. The differential diagnosis is considered and five case reports illustrate the usual findings; one was verified at autopsy. As a rule, most of these patients are asymptomatic and they should be regarded as normal from a clinical standpoint provided the right-sided aorta is not complicated by congenital heart disease. The author could find no evidence that this anomaly is hereditary.

H. J. Teschendorf contributes a critical review of Hand-Schüller-Christian's disease. Here again the differential diagnosis as based on roentgen findings is clearly presented. Roentgen rays must be considered as a valuable therapeutic agent in the treatment of this disease.

The following two contributions deal with diseases of the bone. H. G. Zwerg and W. Laubmann write on marble bones and H. Erbsen writes on osteopoikilosis (osteopathia condensans disseminata).

E. Uehlinger chose for his subject myositis ossificans progressiva, a rare disease which was described for the first time in 1649. So far 160 cases have been reported and Uehlinger adds three of his own; one with detailed post-mortem findings. The only treatment which seems to offer some hope is irradiation by roentgen rays.

W. Teschendorf divides the atelectases of the lungs in three groups: atelectasis due to compression, to obstruction or resorption and to dynamic factors. After a discussion of the diagnosis of the various types their treatment is briefly considered.

G. Herrnheiser and F. Strnad report seven cases of perforation of the renal pelvis and the ureter and then analyze the clinical symptoms, the diagnosis and differential diagnosis. They emphasize the absence of severe subjective and objective clinical symptoms in most of these patients. The roentgen diagnosis is primarily based on the presence of contrast substance outside of renal pelvis, ureter or bladder.

The second part of the book is devoted to therapeutic topics. Radiation therapy of tuberculosis of the female genital organs was, according to W. Bickenbach, already successfully tried in 1910 although its use in peritoneal tuberculosis reaches back to 1899. The suitable cases must be carefully selected and small doses of 35–100 r effective in the diseased tissue seem advisable. Radium is of benefit in the treatment of tuberculosis of the uterus, both fundus and cervix.

F.-G. Dietel recommends the use of radium in the treatment of non-malignant uterine hemorrhage and cites his reasons for preferring radium to roentgen rays. He admits, however, that intrauterine radium application is not a harmless procedure and has a certain mortality.

One hundred and ninety-five cases of carcinoma of the esophagus form the background of A. Zuppinger's contribution. It is noteworthy that only five of his patients were women, a percentage somewhat smaller than reported in the literature. The anatomy, histology, diagnosis and treatment of this neoplasm are related in detail and definite recommendations are given regarding the technique of radiation therapy for palliative or curative purposes. Zuppinger feels that roentgen therapy is the method of choice. Of his 195 patients three are alive thirty, thirty-four and thirty-nine months after the treatment and free from symptoms; those dead from the carcinoma

lived an average of 6.2 ± .36 months after starting treatment.

The present status of radiation therapy in lymphogranulomatosis (Hodgkin's disease) is outlined by E. G. Schultz. In spite of the improvement in technique during the last fifteen years, the statistical results are not very satisfactory, although individual observations show remarkable remissions with freedom from symptoms for years. Moderate doses of 100–150 r per sitting over the involved glands to be repeated every other day up to total doses of 400–600 r are recommended. In cases with mediastinal involvement, the single dose must sometimes be increased to 330 r in order to bring about regression.

W. M. H. Weisswange describes the technique used in some of the leading clinics in the treatment of cancer of the breast, both operable and inoperable patients, by irradiation alone or by operation plus irradiation. The clinical material of the Holfelder institute in Frankfurt from 1920 to 1932 is statistically analyzed showing the results obtained by prophylactic postoperative radiation therapy. Out of a total of 236 patients 64.4 per cent were still alive after three years, 53.7 per cent after five years, 43.2 per cent after eight years and 34.4 per cent after ten years. The influence of the technique on the results during the twelve year period is clearly shown; a distribution of the prophylactic treatment over a two year period following operation seems to offer the patient the best chances. In the advanced stage of the disease as well as in recurrences and metastases intelligent use of roentgen therapy is of considerable value. Especially gratifying are the results obtained in irradiating secondary deposits in bone.

As in previous volumes the reproductions throughout the book are of high quality; each contributor has appended a bibliography of well-selected references. Your reviewer feels free, therefore, to recommend this latest member of the series.

Ernst A. Pohle

A Manual of Radiological Diagnosis for Students and General Practitioners. By Ivan C. C. Tchaperoff, M.A., M.D., D.M.R.E. (Camb.), Assistant Radiologist and Radium Registrar, St. Thomas's Hospital, London. With a Foreword by Philip H. Mitchiner, M.D., M.S., F.R.C.S., Surgeon to St. Thomas's Hospital. Cloth. Price, $6.50. Pp. 256, with 286 illustrations. Baltimore: William Wood & Company, 1937.

In his preface the author calls his book a synopsis of the essentials of radiological diagnosis. The title of the first chapter is "X-ray Physics and Technical Considerations." It consists of three pages of text and three illustrations, the first a roentgen tube, the second a stereoscope and the third a drawing illustrating the action of a Potter-Bucky grid. The second chapter deals with the osseous system in general, and this is followed by one dealing with the same system in a regional manner. Chapters in turn cover the chest, the gastrointestinal tract, the gallbladder and urinary tract, the female generative system and tumors of the spinal cord and ventriculography. The last three chapters are very brief with few illustrations. The list of plates totals 249 of which 179 are included in the two chapters on the osseous system.

According to the preface, the book was written with the hope that it might help the general practitioner to understand the reasoning on which the expert radiologist bases his report of a roentgen examination and to coördinate the latter with his clinical findings. The author hopes, too, that it may be of service to the student since radiology is now a part of routine diagnosis and forms a part of the student's curriculum. Since this is a volume of the "manual" type it must necessarily be limited in scope. It falls short of being an adequate source of information and reference for the student of radiology or for the qualified radiologist. For the undergraduate student and general practitioner, it should fulfill the author's expectations. The illustrations are excellent, the detail is clear. The text is concise and systematically arranged.

A minor point to which exception may be taken, is the classification of Kümmell's disease under osteochondritis of the spine. No mention is made of the osteochondritides described by Calvé and Scheuermann. To the American student, the use of the term myeloma for giant cell tumor may be confusing, likewise ventriculography to include both ventricular and spinal injection of air in the cerebrospinal system for diagnostic purposes.

Ralph S. Bromer

RÖNTGENOLOGISCHE UND PATHOLOGISCH-ANATOMISCHE STUDIEN ÜBER DEN TUBERKULÖSEN PRIMÄRKOMPLEX. (*Acta radiol.*, Suppl. XXXIII.) Von J. Frimann-Dahl und Georg Waaler. Paper. Price, Swed, cr. 9:– Pp. 60, with 24 illustrations. Oslo: 1936.

This monograph is the result of a careful and concise investigation into the manifestations of tuberculosis as seen in unselected autopsy material. The work has been carried out in a systematic and intelligent manner and the conclusions merit consideration.

The authors trace the development of the general concept of the primary tuberculous infection through the workings of Koch, Kuss, Ghon, Ranke, Parrot, Puhl and Schürman, and then present the problem as it has been studied in Norway. The material on which the present investigation is based consists of 200 unselected autopsy examinations at the Rikshospitalet. The patients were largely drawn from the farming districts of southeastern Norway and to a lesser degree from the urban population of Oslo. In addition to the routine examinations, the excised lungs were examined roentgenologically and microscopic studies were made of the diseased areas. A total of 161 calcified primary tuberculous foci were found in 142 (71 per cent) of the cases, the lesions varying from pinpoint to nut kernel in size, the majority, however, being from pinhead to pea sized. Only 75 cases had the complete typical complex with both the pulmonary focus and a corresponding lymph gland lesion. There was a progressive increase in the incidence of the primary complex in the advancing age groups corresponding with the incidence of the positive Pirquet test in this material and in the larger groups studied by Heimbeck and Scheel. Thus the authors believe that the primary complex is by no means always the result of a childhood infection but may appear at any age, although more commonly between twenty and forty.

There were four cases with a positive Pirquet test in whom no evidence of a primary complex was discovered. In two of these no evidence of tuberculosis was found in any of the organs, and in the other two death resulted from extensive tuberculosis. On the other hand, there were six cases in whom a primary complex was found but the Pirquet test was negative. This was considered to be due either to an extremely-long time interval between the original infection and the test or to the debilitated state induced by the terminal illness; included in this group were two with recent active tuberculous lesions in addition to the primary complex.

The authors point out that it is often very difficult to distinguish the healed primary focus from other healed foci and that this is particularly true when the second focus appears either very soon after the primary focus or after an extremely long interval. In the intervening period, when the allergic state is maximal, the tuberculous infection assumes the more common histological appearance. In one case five more or less typical primary complexes were found; in others there were transitions to the Aschoff-Puhl lesions and to the residue of a frankly inflammatory parenchymal lesion.

The primary foci were found equally distributed throughout both lung fields usually near the pleura. The authors point out that a large proportion of the primary foci (over half) recognized in the roentgenograms of the excised lungs are not revealed by intra vitam roentgen studies. They further point out the shadows which may be confused with those of calcified tuberculous foci unless a microscopic examination is carried out, i.e. (1) calcified thrombi or emboli in the smaller blood vessels, (2) intra-alveolar "coral" formations or osteomatous concretions, (3) silicotic nodules, (4) pulmonary vessels viewed in cross section, (5) calcifications in the thickened apical pleura which the authors regard as most often non-tuberculous in nature and (6) small foreign bodies such as small stones or calcified pieces of wood which have been aspirated.

The material is presentably arranged and there are helpful accompanying tables and illustrations, as well as a small bibliography of the pertinent literature.

WILLIAM A. EVANS, JR.

STRAHLUNGEN: WESEN, ERZEUGUNG UND MECHANISMUS DER BIOLOGISCHEN WIRKUNG. (Radiation: Characteristics, Induction and Mechanism of the Biological Effect.) Von Dr. Karl G. Zimmer, Assistent an der Strahlenabteilung des Cecilienhauses Berlin-Charlottenburg. Cardboard. Price, M. 3.20. Pp. 72, with 40 illustrations. Leipzig: Georg Thieme, 1937.

This little book is one of a series of mono-

graphs published under the editorship of W F. Reinig (Berlin) dealing with problems of theoretical and applied genetics and allied fields. Following a few historical remarks, the author discusses the fundamental principles of radio waves, light, roentgen rays and gamma rays of radium. Data on corpuscular irradiation, cosmic and mitogenetic rays are also given. The author outlines briefly his theory regarding the biological effect of radiation based on an analysis of the "injury curve" and the time factor. Because mathematics have largely been omitted in the text it is quite easily understood and therefore suitable for professional and lay readers.

Ernst A. Pohle

The Lung. By William Snow Miller, M.D., Sc.D., Emeritus Professor of Anatomy, University of Wisconsin. Cloth. Price, $7.50. Pp. 212, with 152 illustrations. Springfield, Illinois: Charles C Thomas, 1937.

The summation of virtually a life-time of investigation by an expert in any field of science is always of interest. For anyone who has had the occasion to study Dr. Miller's many contributions to the literature on the lung, there is an added experience in the reading of his able presentation of the gross and microscopic anatomy of the lung in this monograph. The excellence of the illustrations, which serve ably in illumination and emphasis of the text, will command the reader's attention.

The author is known for his demonstration of an emphasis upon the lobule as the anatomic or structural unit of the lung. The relationship of the vascular supply, the venous return and the lymphatic elements for the bronchi, the pulmonary parenchyma and the pleura is admirably demonstrated in correlation with this unit. The gross as well as the microscopic anatomy has been illustrated further by means of pathologic physiology. One chapter contains a thorough analysis of the major historical contributions to the present-day knowledge of the subject.

Its importance is of the order of the contemporary work by Huber on the glomerulus. Other reviewers have aptly considered it a classic comparable to the "De motu cordis."

The physician (whether internist, surgeon, roentgenologist or pathologist) and the investigator, interested in the study and treatment of diseases of the lung, will find this monograph invaluable.

Carleton B. Peirce

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Dide, Maurice, and Leclerc, Pierre. Contribution à l'étude radiographique de la "leontiasis ossea." (Contribution to the roentgen study of leontiasis ossea.) *Bull. et mém. Soc. de radiol. méd. de France*, Jan., 1936, *24*, 56–63.

I. *Clinical Types.* After a brief historical résumé, the authors, stress the two clinical types of leontiasis ossea: (*a*) the Cruveilher type, where the hyperostosis is localized chiefly to the superior and inferior maxillae, and (*b*) the Bernard de Jussieu type, where the hyperostosis has a diffuse homogeneous cranial distribution.

In the present article, 2 cases are discussed in lengthy detail. The first case was published by Ribell in his thesis on exostosis in 1823. The cranium being preserved in the Museum of Toulouse, the author was able to make roentgenograms of it. The second case is a personal one and of recent date. From the point of view of roentgen appearance, in the first case the dystrophy, which was chiefly facial, was generalized to a lesser degree to all of the bones of the cranium except the temporals. In the second, the hypertrophy of the facial bones was particularly evident at the level of the zygomatic arches and hard palate, the mandible appearing normal, but here, too, there was some thickening of the cranium with discrete areas of cotton-like appearance.

II. *Pathogenesis.* (*a*) The first classification of deforming osteopathies was made by Recklinghausen who united in the same group osteomalacia, rickets, Paget's disease and the osteofibrocystic malady. During the course of time, this classification has suffered repeated modification. (*b*) The analogy between craniofacial osteopathies and acromegaly induced Hoppe to consider a possible effect from the side of the glands of internal secretion, especially the parathyroid hormone being taken into account. The views of the various authors, however, differ greatly when it comes to estimating the pathogenesis of hyperparathyroidism. Some of them admit the possibility of such a primary factor, whereas others consider the hyperactivity merely as a compensatory reaction of decalcification. Because of the absence of sharp delimitation of various osteopathies by deficiency or fibrosis, regardless whether they are hypertrophic or not, and because of the possible clinical and experimental coexistence of the two types, it seems preferable at this time to place them all in a common group of osteodystrophies.

III. *Nosographic Diagnosis.* If it is impossible to properly classify leontiasis ossea, it at least seems advisable to draw its limiting borders from the point of view of clinical appearance. Although roentgenographically sometimes it is exceedingly difficult to differentiate between leontiasis and Paget's disease, the osteomalacia and the cystic formation of Recklinghausen show a roentgen appearance which in most instances is quite typical. As it concerns the differentiation from acromegaly the enlargement of the sella turcica in the latter usually serves as a differentiating criterion. Even by admitting a close relationship between leontiasis and Paget's disease, the involvement of the long bones, the curving of the tibiae, the participation of the thorax, and especially the preponderance of the cranial involvement in the Paget's disease are sufficient criteria to make this an autonomous malady. As concerns the subvarieties of leontiasis ossea, the differentiating signs were already mentioned in the introductory remarks.—*T. Leucutia.*

Greenwald, Harry M., and Koota, Joseph. Associated facial and intracranial hemangiomas. *Am. J. Dis. Child.*, April, 1936, *51*, 868–896.

The authors report a case of hemangioma of the brain associated with a nevus of the skin in a boy five years old. They collected 81 additional cases reported in the literature and analyzed them in detail in the paper. In general, the symptoms of this disease are: (1) convulsive seizures which in the majority of the cases have been Jacksonian in type; (2) hemiplegia; (3) mental retardation, and (4) nevus

of the skin. Other symptoms may result from ocular changes.

They emphasize the fact that in every case of so-called idiopathic epilepsy a careful search should be made for a nevus about the face, head or neck. If present, cerebral hemangioma should be suspected and roentgenologic studies of the skull should be made for further confirmation.

In the case here reported, a hemangioma was found at operation in the left parietal region. He had also a nevus on the left side of the face and previous to his admittance to the hospital, a diagnosis of duodenal ulcer had been made which was verified on roentgenologic examination to the extent that a definite deformity of the duodenal cap was present. After operation it was suspected that the patient had a nevus involving the duodenum which was responsible for the deformity found in the duodenal cap. Tarry stools tended to confirm this opinion. The child received postoperative radium irradiation. His present condition is excellent and he has had no convulsions and has complete use of his arms and legs with no apparent impairment of his mentality.

There is a difference of opinion whether these hemangiomas are congenital vascular anomalies or neoplasms. Operative treatment, with irradiation, is recommended as offering the best results.—*R. S. Bromer.*

CARDILLO, FURIO. Sul valore dell'indagine radiologica e in particolare della ventriculografia nella diagnosi dei tumori della fossa cranica posteriore. (The value of roentgen examination and particularly of ventriculography in the diagnosis of tumors of the posterior fossa of the skull.) *Radiol. med.*, Feb., 1936, *23*, 90–110.

Tumors of the posterior fossa of the skull soon affect the whole brain and cause serious general symptoms. Early diagnosis is therefore important. Neuroniomata or neurofibromata of the acoustic nerve are the most frequent tumors of the posterior fossa. Even when they undergo cystic degeneration they never show calcification and are therefore not demonstrable without contrast. Various other forms of tumor may occur, including meningiomata, medulloblastomata, neuro-epitheliomata, hemangioblastomata, etc., some of which may contain calcium.

Until cerebral pneumography came into use, the only means of diagnosis were direct visibility of the tumor because of a calcium content sufficient to furnish contrast, the existence of changes in the skull bones caused by the tumor or changes in the skull bones caused by hypertension resulting from the tumor. None of these methods were very satisfactory, however, and it is only by the aid of direct ventriculography that the best results are obtained. This has the advantage over encephalogography of not being at all dangerous and it permits of diagnosis in a large number of tumors of the posterior fossa that are extremely hard to diagnose otherwise. The author describes 5 such cases verified by autopsy and gives the ventriculograms showing the typical changes.—*Audrey G. Morgan.*

BÉTOULIÈRES, PIERRE, and BALMÈS, JEAN. L'exploration radiologique de la mastoïde chez l'enfant. (Roentgen examination of the mastoid in children.) *Bull. et mém. Soc. de radiol. méd. de France*, Jan., 1936, *24*, 88–100.

I. *History.* The historical review of the use of roentgen examination of the mastoid in children dates back to only 1913 but even so the number of publications is very meager.

II. *Anatomical Considerations.* According to the pneumatization, one may distinguish four types of mastoids: the diploic, the pneumatic, the compact and the mixed type. Concerning the evolution of pneumatization in early childhood, the publication of Witmaak is now classical. According to this (1) during the first year there are present only the three principal cavities of the middle ear, the mastoid region being formed by a spongious tissue without aerated cavity; (2) towards the end of the first year the accessory cavities develop at the expense of the primitive cavities by formation of large cells which close in secondarily. This period lasts for five years, the mastoid gradually changing its structure from that of spongious to that of pneumatic; (3) after the fifth year, a double evolution follows; on the one hand there is accentuation of the pneumatization and on the other a localized condensation of the spongious tissue. If this latter predominates the mastoid becomes compact, but in most instances there is an equilibrium resulting in the mixed type of mastoid. Sometimes, the evolution becomes atypical and pneumatized mastoids appear even during the first

years of life. Whatever the structure may be the mastoid process incloses from birth a cavity which is called the mastoid antrum. In the fetus at term the antrum is situated above and a little behind the external auditory canal but later it is gradually displaced backwards, downwards and inwards so that in the adolescent it is situated within a distance of 7 mm. from the auditory canal. After that period, the dimensions of the antrum vary little.

III. *Roentgen Techniques.* (1) Bilateral incidences. These permit the visualization of the transparency of the entire mastoids. They are of importance when the pneumatization is sufficient to permit comparative study. The most preferred incidence is the fronto-occipital of Worms and Bretton. (2) Unilateral incidences. These include the three classical types (*a*) the zygomatic occipital incidence (Stenvers); (*b*) the temporo-tympanic incidence (Schüller), and (*c*) the fronto-tympanic incidence (Mayer). The author discusses in detail the appearance of the mastoids with any of these incidences, using several roentgenograms and drawings for illustration.

IV. *Interpretation in the Pathologic Cases.* This part is limited only to the inflammatory affections. Roentgen examination is indicated especially in two instances: in case of an otitis media to determine the extent of the lesion, chiefly as it concerns the involvement of the mastoid, and in generalized infection to determine if there is anything pathological as far as the ears are concerned. This latter applies mostly to very early childhood where inflammation of the ear may lead to some rather vague symptoms such as vomiting, diarrhea, elevation of temperature and rapid general decline. The best method is to take two roentgenograms on each side, one with the Mayer and the other with the Schüller incidence and then to make a fifth roentgenogram of the ensemble according to the incidence of Worms and Bretton.

(1) Lesions of the Antrum: The incidence of choice is that of Mayer. The first pathologic modification is that of a slight fogging, although this is not an absolute sign of disease since the antrum may appear slightly hazy during the evolution of the pneumatization process. The comparative study of the two sides in this respect is of greater pathological significance.

(2) Mastoiditis: (*a*) In very young children the pneumatization being absent or rudimentary, the authors attach great importance to the sign of Granger which is as follows: In the Schüller position the sigmoid groove becomes visible only from the second and third year on. It is only exceptionally that it is visible sooner either because of precocious pneumatization or because of abnormally superficial localization. If, therefore, the groove of the lateral sinus becomes visible under the age of three this indicates a marked destruction of the bone. (*b*) In children of more advanced age when the pneumatization is sufficiently advanced the reontgen signs of mastoiditis are identical with those observed in adults. One may mention the additional sign of Bernard and Lemée, although with the reservation that this sign may appear inconstant. It consists in the following: In the Schüller position the semicircular canals appear under the age of one. If the canals are visible after the age of two one may surmise an osseous destruction of the mastoid process.

V. *The Value of Roentgen Examination.* There can be no doubt that the use of roentgen examination of mastoids in childhood is making great strides. The authors advise that the method be used systematically in all children where there is a suspicion of mastoiditis.—*T. Leucutia.*

Daniel, Gaston. La roentgenthérapie des affections inflammatoires en oto-rhino-laryngologie. (Roentgen therapy of inflammatory affections in oto-rhino-laryngology.) *Bull. et mém. Soc. de radiol. méd. de France*, Jan., 1936, *24*, 113–122.

For the past few years an increasing interest has been shown in the indications and results of roentgen therapy in that surgical specialty which is called oto-rhino-larynology. In a manner similar to other localizations, roentgen therapy applied with adequate technique will permit (1) an immediate resorption of phlegmonic processes at a sufficiently early stage; (2) a localization of the inflammation with disappearance of the local hyperemia and peripheral lymphangitis in the more advanced stage, in which the method is associated not infrequently with surgical drainage of the restricted focus, and (3) a gradual amelioration and complete clearing up with eventual sclerosis of the tissues in the chronic stage. The im-

mediate reaction which so often follows the application of roentgen rays to the inflammatory focus is very similar to the reaction observed after hypodermic injections of vaccines and hence irradiation in the acute and especially the subacute forms may prove unwise or even dangerous, when the proper drainage is not established first.

In résumé, application of roentgen rays constitutes a method which is extremely powerful and active in the treatment of inflammations. It is absolutely harmless when one treats chronic infections which are well drained but a real danger exists in the acute and especially subacute phase where a large and constant drainage must be established before proceeding with irradiation. This explains why radiotherapists have always confined themselves to the treatment of chronic cases in all inflammations of the sinuses and of the mastoid, constantly refusing to deal with acute sinusitis or mastoiditis. It is the author's opinion, however, that if a proper preliminary surgical drainage has been established treatment may be used to advantage even in such instances.

With these general principles in mind, the author then deals in extenso with the value of radiation therapy in (1) tonsillitis and pharyngitis; (2) otitis; (3) sinusitis and mastoiditis, and (4) larnygitis.

As concerns the technique, it appears from a perusal of all these chapters that the minimum dose which is applied in the acute and subacute cases is from 20 to 40 r per seance, treatment being repeated within two or three days. Later, as the inflammation becomes more quiescent, the doses may be suitably increased. In the chronic cases the doses vary from 80 to 100 r in suppurative otitis, sinusitis and mastoiditis, but in the chronic hypertrophic tonsils it may be pushed as high as a total of 3,000 r per field.

No comprehensive statistics of the results obtained are given but on the basis of personal experience radiation therapy is recommended more extensively than used heretofore. A comparison with other physiotherapeutic methods such as infra-red and ultraviolet rays, medical diathermy, high frequency, etc., shows that roentgen therapy occupies among them an equally important position.—*T. Leucutia.*

BERCHER, J., and DUGUET, J. A propos de trois cas d'ostéite syphilitique maxillo-nasale. (Concerning three cases of syphilitic maxillary nasal osteitis.) *Presse méd.*, Feb. 29, 1936, *44*, 339–342.

The predilection of hereditary or acquired syphilis for the facial bones is a well-known fact. Numerous examples of gumma limited to the superior incisive region have been reported and one is now accustomed to consider the intermaxillary area as a point of attraction of syphilitic infection. A perusal of the cases published in the medical literature reveals that in many instances the syphilis extends beyond the incisive region involving other facial bones such as the hard palate, nasal septum, the bones of the nose proper, etc.

The authors recently had the opportunity of observing 3 cases of syphilitic osteitis with similar localizations and they now report these cases in extenso. In the first case the gumma was single and limited to the incisive region but in the other 2 there was concomitant involvement of other points of facial bones. The roentgenograms proved of great interest inasmuch as they revealed the more marked extension as compared to the clinical examination. The conclusion is reached from these cases that syphilis does not always remain localized to the incisive region but has a tendency to invade other parts of the facial skeleton or even the frontal bone.

Clinically such cases represent as a rule, patients who were treated poorly or had no treatment at all. An early diagnosis with the aid of roentgenography is of great importance because the institution of immediate treatment may prevent more widespread mutilations which are usually sequelae of syphilitic osteitis. Even so, many times the syphilis shows an extremely grave course and the destruction of the bones of the maxillary nasal region continues in spite of specific treatment. The only therapeutic form left is then prosthesis as soon as a sufficient cicatrization has been brought about.—*T. Leucutia.*

NECK AND CHEST

SOLIS-COHEN, LEON, and LEVINE, SAMUEL. Congenital atresia of the esophagus with tracheobronchial fistula. *Am. J. Dis. Child.*, May, 1936, *51*, 1119–1125.

Solis-Cohen and Levine report a case of congenital atresia of the esophagus with a tracheobronchial fistula. The symptoms were masked by dyspnea which was suspected to be

of thymic origin. The patient was a male infant, who lived for eight days. The roentgen examination showed the abdomen distended by a dilated stomach and by dilated loops of small bowel containing air. The trachea lay in an anterior position. The upper part of the esophagus ended in a blind cul-de-sac above the bifurcation of the trachea and was dilated. Roentgenograms made without barium sulphate in the esophagus showed an absence of air in the proximal segment of the esophagus which was considered as a fairly common finding in the chest of new-born infants. Extending from the bifurcation of the trachea to the stomach was an airway, pencil-like above, but dilated below. This was believed to represent the lower end of the esophagus.

Roentgenograms taken after death and after the injection of barium sulphate into the trachea revealed the tracheobronchial fistula, the terminal airway of the esophagus filled with the medium, and an outline of the pulmonary bronchial tree. A catheter was passed directly from the mouth into the trachea and thence through to the stomach.

The authors consider that new diagnostic criteria were found by them, which are based on the abnormalities revealed by the roentgenograms, namely, the terminal part of the esophageal airway leading into the stomach from its fistulous origin, and the absence of air in the upper part of the esophagus which was filled with retained secretions. They suggest that in dyspneic new-born infants who vomit and whose stomach and intestines are distended by air, the possibility of esophageal atresia must be excluded before a diagnosis of thymic disorder is made. The rôle of the thymus gland in producing extreme dyspnea is still a moot point. The associated pulmonary emphysema and atelectasis may possibly have been etiologic factors in the production of the cyanosis.—*R. S. Bromer.*

Schaaff, F.-A., Jung, A., and Froelich, F. Oesophage pré-sternal. (Presternal esophagus.) *Bull. et mém. Soc. de radiol. méd. de France.*, Feb., 1936, *24*, 152–153.

The authors present a case of artificial, prethoracic esophagus in which the operation was performed for an old progressive cicatricial stenosis from ingestion of caustic soda. The operation was carried out by Drs. Jung and Froelich in four stages after preliminary gastrostomy. First stage: construction of a presternal cutaneous tube; second stage: liberation of a jejunal loop and implantation of this on the stomach on one side and at the inferior extremity of the cutaneous tube on the other, being careful to maintain one of the arteries for proper nutrition; third stage: esophagostomy; liberation of the esophagus by saving the largest number of nourishing vessels and being careful to maintain intact the superior orifice of the esophagus with its musculature; fourth stage: union of the esophageal orifice with the superior orifice of the presternal cutaneous tube. Following healing, there was a very satisfactory function, and roentgen examination by means of a barium meal revealed that the barium passed into the stomach by traversing the new canal within ten seconds. It was interesting to find that the thick opaque mixture traversed the inert, indifferent and rigid canal without delay simply as a result of the muscular contractions of the hypopharnyx and the superior orifice of the esophagus, a fact which proves that the musculature of the esophagus is unnecessary in the vertical position if there is no presence of stenosis, and that, in consequence, the pretended megaesophagus due to atony is physiologically impossible. Furthermore, it was observed that isoperistaltic contractions of the loop of the small bowel serving as an anastomosis between the inert cutaneous canal and the stomach actively drove the bolus toward the stomach. Finally, there was absence of the air pocket in the stomach, this having been replaced by the presence of air in the artificial prethoracic canal.—*T. Leucutia.*

Lawrence, Knowles B., and Hersperger, W. Grafton. Mixed tumor of the mediastinum of mesenchymal origin. *Am. J. Dis. Child.*, April, 1936, *51*, 856–867.

The occurrence of a tumor primary in the mediastinum and not originating from normal mediastinal structures is rare, particularly in children. The case here reported is remarkable because pathologic study of the neoplasm revealed it to be malignant and composed of tissues derived from the mesoderm alone.

The patient was a boy three years and three months old, of Italian-American parentage. The tumor developed insidiously and occupied a large portion of the right chest when first suspected. The roentgenogram on the first

examination showed increased density in the right chest extending from the second rib downward to the diaphragm with air above this and a suggestive fluid level. The cardiac shadow was displaced toward the left. A roentgenogram taken three weeks later revealed an extension of the tumor mass. Still later roentgen examination after radiation therapy indicated some shrinkage of the tumor.

Pathologic study of the specimen after autopsy showed a cellular, relatively anaplastic tumor with differentiation in the form of cartilage and connective tissue of a myxomatous type. Significant features were the presence of elements solely from the middle germinal layer and the high degree of malignancy.—*R. S. Bromer.*

KOHN, JEROME L. Postpneumonic residual infiltration. *Am. J. Dis. Child.*, May, 1936, *51*, 1101–1113.

Kohn reports a group of 10 patients who continued to have symptoms of pulmonary involvement from two to ten years after their original admission for an acute nontuberculous pulmonary involvement. These patients were seen at frequent intervals after the onset of pneumonia. They were analyzed from the point of view of persistence of roentgen signs, physical signs or symptoms such as cough. The conditions did not fall into any set group. All the patients were children. Only one child died. The remainder developed normally. None at the present time have any stigmas of suppurative involvement of the lung, such as clubbing of the fingers or purulent or fetid expectoration. One child, who possibly had an acquired cyst, and another, who probably had a pleural or pulmonary cavity behind the heart are discussed in the paper in more detail because of the therapeutic problems involved. In neither of these cases did Kohn believe that tuberculosis was an etiologic factor.

He believes that the chance for recovery of patients with residual infiltration after the ordinary acute attacks of pneumonia is excellent. Only rarely do symptoms persist for years. As a rule, the presence of persistent symptoms does not indicate severe damage to pulmonary tissue. Clinical bronchiectasis is rarely found.

Allergic sensitization or involvement of the accessory nasal sinuses did not seem to be important in aggravating or maintaining pulmonary infiltration.—*R. S. Bromer.*

CHOBOT, ROBERT. Bronchiectasis as a complicating cause of asthma. *Am. J. Dis. Child.*, Oct., 1936, *52*, 882–886.

A case of infective asthma in a child of eight years is reported. An unusual feature of the case was the fact that bronchiectasis developed despite therapy directed to the initial focus of infection in the nose and remained undiagnosed until iodized oil was injected. The asthma became controllable when the bronchiectatic cavity was emptied. This treatment lasted for a year, consisting only in repeated bronchoscopic treatments, and has resulted in a definite improvement in the general health of the patient.

The roentgenograms illustrate, in this patient, that bronchiectasis can be present without evidence of a triangular shadow at the base of the lungs. The importance of the injection of iodized oil is emphasized.—*R. S. Bromer.*

FEGIZ, LUZZATO. Sulle immagini pseudo-cavernose e sulla possibilita di rapida elisione di caverne polmonari dopo intervento cellasoterapici. (Pseudocavity images and the possibility of rapid disappearance of lung cavities after collapse therapy.) *Radiol. med.*, Feb., 1936, *23*, 116–119.

Some time ago the author published 3 cases of cavity in the lungs in which the cavities disappeared promptly after collapse treatment by pneumothorax. Toniolo questioned his findings and claimed that the annular images were probably caused by sacculated spontaneous pneumothorax and not by cavities, and that they would not have disappeared so quickly if they had been real cavities. Fegiz maintains that there is no doubt that the pictures seen by him were those of real cavities, that it is possible for cavities to disappear within a few weeks after collapse treatment and that pseudocavities caused by encapsulated spontaneous pneumothorax are rare and are of little importance in comparison with the frequency of real tuberculous cavities.—*Audrey G. Morgan.*

BAGLIANI, MARIO. Il polmone policistico. (The polycystic lung.) *Radiol. med.*, Dec., 1935, *22*, 1055–1077.

Nine cases of polycystic lung are described and illustrated with roentgenograms. The author concludes that it is not possible to make

a diagnosis of polycystic lung from simple roentgenography without the use of contrast medium. There are only a few cases of pure polycystic lung without superadded inflammation and these are the only cases in which simple roentgenography is sufficient for examination. They show the characteristic picture with intersecting rings or a network with delicate septa fine as capillary lines. There was not one of these pure cases in the author's material. But by means of bronchography with the use of iodized oil it is possible not only to make a diagnosis of polycystic lung but to differentiate it from bronchiectasis and to differentiate between the congenital and acquired forms of polycystic lung. Bronchography shows whether there is aerated lung tissue in the polycystic lung, which is a means of differential diagnosis between the congenital and acquired forms. The demonstration of the relation of the cysts to the various orders of bronchi, small medium and large, is important in the differentiation between bronchiectasis and cysts properly speaking.—*Audrey G. Morgan.*

Harper, Paul. Treatment of lobar pneumonia in children by artificial pneumothorax. *Am. J. Dis. Child.*, March, 1936, *51*, 536–561.

Harper reports a study of the treatment of lobar pneumonia with artificial pneumothorax in 22 children, without fatality. The ages of the children varied from fifteen months to fifteen years. Most of them required sedatives and for this purpose morphine gave excellent results.

A rise in the interpleural pressure averaging +4 cm. of water was observed when patients who had been lying on their sides during the injection of air were turned on their backs. Since the extent of the rise varied with the age and other factors, it seemed best to treat the children in the supine position. Thus Harper's readings of the interpleural pressure are from 0 to +7 cm. of water higher than they would be if the patients had been lying on their sides, with the collapsed lungs upward.

Harper considers that, in general, the results of compression of the pneumonic lung were encouraging when early and good collapse was obtained and the results were of doubtful value when compression was either delayed or incomplete. He found that more complete and rapid compression of the lung without discomfort to the patient was obtained by decreasing the rate of injection of air used in the early cases to a speed of from 7 to 9 c.c. of air per minute, but at the same time increasing the amount of air, especially on the initiation of pneumothorax. His observations, although limited, suggested that the interpleural pressure needed to give early and good collapse varies with the age of the child and also, with the extent of the pneumonia infiltration. He gives tentative levels of pressure which gave satisfactory collapse in children under three years, between four and six years and older than six years. The interpleural pressure was pushed slowly toward these tentative levels, with reliance on the symptomatology, especially beginning dyspnea, and on evidence of mediastinal shift for warning to stop. In all of his cases respiratory distress passed away within a few hours. At the first renewal of air, after an interval of about four hours, the pressure was carried to higher levels without causing disturbing symptoms.

After pneumothorax was established, the usual physical signs were so obscured or altered that it was necessary to rely on the roentgenograms to follow the extent of the collapse and the course of the pneumonia. Roentgen examination was also necessary for the diagnosis of mediastinal hernia and of adhesions, particularly to differentiate between preëxisting fibrous pleural adhesions and temporary adhesions formed during the course of the pneumothorax. In addition to this dependence on the roentgenogram, consideration should be given to the amount of time which the procedure requires and to the usual technical requirements for performing pneumothorax. These are factors which must be considered before this form of treatment is begun. Harper's experience showed the importance of initiating pneumothorax before the pneumonic infiltration had become diffuse.

In summary, Harper believes the value of the procedure is still a clinical and an experimental problem.—*R. S. Bromer.*

Lindskog, G. E., Harper, P., and Friedman, I. Changes in lung volume during treatment with artificial pneumothorax for lobar pneumonia. *Am. J. Dis. Child.*, March, 1936, *51*, 523–535.

The authors carried out complete studies of lung volume by the technique of Christie in 3 cases of lobar pneumonia during treatment

with artificial pneumothorax. Lobar pneumonia, they found, was associated with a reduction in the subtidal volume of the lungs early in the disease, as compared with the values during convalescence. The introduction of measured quantities of air into one pleural cavity was attended by decreases in the subtidal volume of the lungs, but always quantitatively less than the volume of introduced air. Similarly, the withdrawal of air from a pneumothorax cavity caused a rise in the subtidal volume, but less than the amount of air removed. A gradual reduction in the subtidal volume to a level only 50 or 60 per cent of the normal was not attended by a failure of the mechanism of external respiration, even in the presence of infection in the respiratory tract.

When large volumes of air are introduced into the pleural cavity, there is an increase in the size of the chest, which can be demonstrated in these cases physically and by roentgen measurements. There is also a drop in the level of the diaphragm toward the inspiratory position. Also shifts in the mediastinum and pleural adhesions may be factors in producing the above mentioned results.—*R. S. Bromer.*

CODET, P. H., and BONTE, G. Deux cas de calcification du péricarde. (Two cases of calcification of the pericardium.) *Bull. et mém. Soc. de radiol. méd. de France*, Feb., 1936, *24*, 134–139.

The deposit of calcareous salts at the level of the pericardium gives rise to the so-called heart en cuirasse, or armored heart. It is interesting that in most instances there is no clinical symptomatology so that the condition is usually found accidentally during roentgen examination for some other cause. The authors recently had the occasion to observe 2 such cases, one having come to examination for general loss of weight, and the other because of palpitation of the heart, although there were no other cardiac findings and the electrocardiogram remained negative. In this latter case a kymographic examination supplemented the usual roentgenoscopic and roentgenographic procedure.

The following general conclusions are reached: The image of calcareous deposit is always localized to the right border and inferior surface of the heart. The explanation for this lies in the fact that the maximum of expansion of the cardiac walls occurs at this level. The calcareous deposits, as a rule, produce no important clinical disorders, except when extending to the territory of the His bundle; they cause no modification of the rhythm of the heart and the electrocardiogram remains negative; moreover kymography revealed that there is no change whatever of the diastolic and systolic movements. This latter observation is very interesting, since it was assumed that the movements in an armored heart suffer because of the lack of expansibility. For the same reason, the authors believe that the term of heart en cuirasse or armored heart is a misleading one, reflecting merely a morphologic and not a physiologic state. As concerns the method of examination, there is no doubt that the roentgen procedures constitute the method of choice. Roentgenoscopy has certain value but roentgenography in the oblique incidences, especially the left anterior oblique, and in the left profile, furnishes more precise information. Finally, kymography permits a very accurate evaluation of the physiologic state.—*T. Leucutia.*

SCHAAFF, F.-A. Coeur en cuirasse, examen radiologique in vivo et nécropsique. (Heart en cuirasse; roentgen examination in vivo and at necropsy.) *Bull. et mém. Soc. de radiol. méd. de France*, 1936, *24*, 153–154.

In 1921 the author reported for the first time 2 cases of calcification of the pericardium. Since then the number has increased to more than 6, which proves that the condition is not very rare. In the present article a case is reported which was controlled at autopsy. As concerns the technique of roentgen examination it is recommended that more penetrating rays be used than usually practised for chest roentgenography to bring out to advantage the calcareous incrustation. Especially the left anterior oblique and the lateral incidences are of greatest value. In the case reported the left ventricle was surrounded by a dense band which was nearly semicircular, commencing just underneath the border of the auricle and extending down to the apex where it continued on the inferior surface of the heart to the left border of the vertebral column. From this band, calcareous extensions occurred on the anterior surface of the heart, producing a reticular image. Because of the fact that the calcareous shell had inclosed practically all of both ventricles, the heart represented di-

minished movement at the roentgenoscopic examination. Clinically the patient was an old rheumatic, but the pericarditis could not be diagnosed, all signs remaining negative. At the autopsy the findings of the roentgen examination were confirmed, the roentgenogram of the anatomic specimen being exactly identical and superimposable on that made in vivo.—*T. Leucutia.*

Westermark, Nils. Studien über die Bewegungen des Herzens. (Studies of the movements of the heart.) *Acta radiol.*, 1936, *17*, 235–251.

Cases with normal hearts were examined by roentgen kymography and at the same time Abramson recoil curves and electrocardiograms were made. The results of all three methods of examination were compared. The roentgen kymogram of the left ventricle shows two phases, an inward and an outward movement. Contraction of the ventricle is shown by an indentation during the outward movement. This is probably due, as Ludwig claims, to the heart becoming somewhat more upright during the contraction. At the beginning of systole, the outward movement continues and changes to an inward movement 0.1 to 0.2 seconds after the conclusion of the QRS complex. A recoil effect is probably a contributory cause of the inward movement. This theory is discussed.—*Audrey G. Morgan.*

Westermark, Nils. Soll man die Phrenicoexhaeresis bei Pneumothorax vornehem? (Should phrenico-exeresis be performed in pneumothorax?) *Acta radiol.*, 1936, *17*, 284–289.

A case is described in which pneumothorax was not giving satisfactory results. Phrenico-exeresis was performed and resulted in an acute attack of suffocation which required emptying of the right pneumothorax. The mechanism of the procedure is discussed and it is shown that phrenico-exeresis is always contraindicated in total pneumothorax. It may be indicated in partial pneumothorax when the basal portion of the lung is quite strongly adherent to the wall of the thorax, the diaphragm and the mediastinum.—*Audrey G. Morgan.*

ABDOMEN

Gutmann, René A., and Jahiel, R. Les sténoses du pylore et les gastrites ectasiantes. (The stenoses of the pylorus and the ectatic gastrites.) *Presse méd.*, Jan. 25, 1936, *44*, 155–157.

Two classical types of pyloric stenosis are known: (1) the organic stenosis representing a definite process of evolution usually due to ulcer, cancer, adhesions, hypertrophy of the pylorus, cicatrix in gastritis, etc., and (2) the spastic stenosis mostly of temporary duration and due to an irritation of close or distant extrinsic origin. It is the authors' conviction that one may differentiate a third, inflammatory stenosis, which is the result of a malady of the entire stomach, the so-called ectatic gastritis.

In this article the authors briefly consider all three forms of stenosis, using 16 roentgenograms for illustration. Concerning the inflammatory stenosis they state that the ectatic gastris when associated with pyloritis acts on the pylorus by producing an edema and on the stomach by producing a paresis. The combination of the two roentgenographically results in a picture of stenosis which, however, under proper medical treatment completely disappears within a few days, thus proving the temporary nature of the lesion. On re-examination the stomach may assume an entirely normal appearance or, if an old ulcer was at the basis of the lesion, a classical picture of this may be noted. The knowledge of the inflammatory stenosis is important from a therapeutic standpoint since an immediate operation to which one is apt to resort may be prevented.—*T. Leucutia.*

Bouton, E. L'ulcère aigu du bulbe duodénal. (Acute ulcer of the duodenal bulb.) *Bull. et mém. Soc. de radiol. méd. de France*, Feb., 1926, *24*, 166–168.

During the past few years, the roentgen diagnosis of duodenal ulcer has made real progress. A great many articles have appeared recently contributing to such progress. The author reports his own technique which is as follows: The Berg frame is used, which permits the taking of a series of four images on the same film of the localized portion of the duodenum. The examination is always made in a vertical position and a dosed compression used when necessary. (1) After making a survey of the rugae of the gastric mucosa by administering a mixture of half porphyrized barium sulphate and half water, two or three additional swallows of the same liquid are

given and the duodenal bulb filled by slightly massaging the stomach. (2) After the bulb is injected, the Berg frame is centered and a first roentgenogram made en face. (3) The patient is placed in the anterior left oblique position and, after the bulb is well separated from the spinal column, a second roentgenogram is made showing the posterior surface of the bulb. (4) The patient is again placed in the frontal view, the bulb filled and the dosed compression applied until the appearance of the mucosal folds, and additional roentgenograms made.

In the present article 11 cases of acute ulcer of the duodenal bulb in which the above technique was successfully used are briefly discussed.

As concerns the clinical symptomatology, the cases belonged either to a group who came for the first time to observation or to a group who had had repeated attacks, the examination being made for the recurrence of such an attack. In all instances there was a very intensive pain, associated with daily vomiting. The roentgen diagnosis offered no difficulty but it was noted that in the acute cases the niche, which was localized to various aspects of the bulb, was surrounded by a zone of edema of the mucosa, whereas when the clinical symptoms subsided the edematous halo around the niche disappeared, and there was a gradual reduction in the size of the niche proper.

The author, in conclusion, stresses the value of the examination in the vertical position and the manipulative artificial filling of the bulb which permits a good examination even of a ptotic stomach in the vertical position.—*T. Leucutia.*

BLACK, ROBERT A., and BENJAMIN, EUSTACE L. Enterogenous abnormalities; cysts and diverticula. *Am. J. Dis. Child.*, May, 1936, *51*, 1126–1137.

The authors state that from the pathologic point of view it is known that cysts and diverticula occurring in the intestinal tract, including those of the true enterogenous type, frequently cause obstructive and other phenomena. Clinically it is hard to determine the presence of such an abnormality during life, even with the help of roentgen investigation. They report a case which serves as an example of enterogenous abnormalities with rather peculiar accompaniments, found in an infant at necropsy.

In an infant, five and one-half months old, there was found at autopsy a large retromediastinal enterogenous cyst attached to the left ventrolateral aspects of the thoracic vertebrae and projecting into the left side of the thoracic cavity. There was also an enterogenous intestinal pouch or diverticulum, 10 cm. long, in juxtaposition to and partly fused with the jejunum, and having a mucous-lined orifice close to each end communicating with the lumen of the bowel. There was a perforating peptic ulcer slightly above the proximal communication with the jejunum. Death was apparently due to peritonitis following the perforation of the wall of the diverticulum by the peptic ulcer.

The roentgenograms made at the time of admission to the hospital showed a slight infiltration in and about the hilus of the right lung with marked cloudiness involving the entire left lung and with some compression of the lung throughout, giving the appearance of a partial pneumothorax. Above the hilus of the left lung there was a denser shadow thought to be possibly due to a mucous plug or foreign body in the left bronchus. There was considerable distention of the stomach and bowel. The roentgen examination of the gastrointestinal tract showed a spastic colon.

Of special interest in this case is the finding of a perforated peptic ulcer in the intestinal diverticulum and the fact that there were two orifices connecting the interior of the diverticulum with the lumen of the intestine. Usually these large cysts offer no clinical signs and symptoms other than those of pressure. It is difficult to explain many cases of multilocular enterogenous cysts and diverticula by any theory that the anomalies are due to pinching or incarceration of the intestinal wall during development or are merely scattered remnants of the vitelline duct. While the cyst and diverticulum in the authors' case may have originated from remnants of the vitelline duct, this theory does not explain the mesenteric location of the diverticulum, nor does it explain the duplications of the lower portion of the bowel, found at autopsy, below the cecum.—*R. S. Bromer.*

CHIRAY, M., and LOMON, A. L'exploration radiologique directe des voies biliaires; épreuve complémentaire de la cholécystostomie. (Direct roentgen examination of the biliary ducts; complementary study of cholecystostomy.) *Presse méd.*, Feb. 22, 1936, *44*, 300–303.

After a brief historical review, the authors discuss the value of lipiodol injection in cases of established gallbladder drainage to elicit the possible causes of pathology in the gall ducts. This method was appropriately called by Bérard and Mallet-Guy the "biliary passage test."

There are certain reports in the literature which suggest that the method may be dangerous. When the lipiodol through forceful pressure passes into the Wirsung canal of the pancreas, hemorrhagic pancreatitis may develop which not infrequently terminates fatally. The authors consider in lengthy detail all the reported accidents, discussing or interpreting the factors which might have helped to prevent them or to forestall similar occurrences in the future.

As concerns the method itself, the following procedure is recommended: The examination is carried out within two to three weeks after cholecystostomy; the patient being on an empty stomach, the lipiodol is injected under roentgenoscopic control using very careful pressure. The oil is warmed up to body temperature so as to reduce its viscosity. It is essential that a syringe with a free piston be used for the purpose of injection so as to be able to regulate the pressure. Furthermore, it is important that the injection be carried out in such a manner that no reflux of the oil results, a fact which may obscure the roentgen image, leading to faulty interpretation. Once the cannula is introduced into the cholecystostomy opening, it must be left in situ until the examination is completed. For the control of pressure the same manometer is recommended that is used for hysterosalpingography, the amount of pressure being identical. When there is free passage the lipiodol passes into the duodenum, thus being spontaneously eliminated, but when there is obliteration an effort must be made to withdraw immediately after the roentgen examination as much as possible of the injected lipiodol. The normal biliary passage, the route of which is described in detail, is characterized chiefly by the absence of pain during the injection. The amount of lipiodol which the gallbladder admits is 15 to 20 c.c. The emptying commences after two to five minutes by rhythmic contractions and is completed in about fifteen minutes. As a rule, three roentgenograms are made during this interval showing the various phases of the passage.

In case of cholecystitis and choledochitis, lipiodol injection through the cholecystostomy reveals a marked dilatation of the gallbladder and choledochus. The lipiodol is usually blocked by the spastically closed sphincter of Oddi which is opposed to the incontinence of the upper biliary ducts. The gallbladder itself appears inert without the slightest emptying contraction.

The characteristic signs of stasis are the easy and non-painful distention of the gallbladder, which admits 30 to 40 c.c. of the lipiodol, and the fitful delayed emptying which commences only after fifteen to twenty minutes. In contradistinction to this, the injection of intolerant gallbladders is painful. The gallbladder contracts actively, driving the lipiodol toward the gall ducts. Because of the insufficient outlet of the sphincter of Oddi a reflux takes place into the hepatic duct and the intraparenchymatous biliary canals of the liver.

In infectious icterus the biliary passage occurs normally except for the fact that the choledochus is filiform and the ampulla of Vater enlarged, due to the fact that there is an edema of the mucosa of the choledochus and a dilatation of the ampulla of Vater.

When there is evidence of a stenosis due to calculus, narrowing of the lumen, or extrinsic compression, the mechanism of the biliary passage is entirely different. In this case the lipiodol, as soon as it has forced the cystic duct, ascends into the hepatic duct and its dilated branches. The dilatation may be so considerable that it transforms all of the high biliary ducts into a veritable reservoir. In case that the site of obstruction, as this occurs chiefly in calculi, is in the inferior portion of the choledochus, this latter may appear as large as the dilated hepatic duct. The abrupt interruption with eventual inverse cupule-like appearance makes the diagnosis of stone certain. If the obstruction is the result of pancreatitis or cancer the choledochus may appear closed at its origin and thus remain completely invisible. The persistence of the site of obstruction in subsequent serial films is then most important in differentiating from an inorganic spasm.

The final conclusion is reached that this new method of examination represents a great clinical interest. The cholecystostomy is the first step and the lipiodol examination through the surgical fistula the second. It is fortunate that in many instances, thanks to the information

gained, the third step may act as savior, by either removing the stone or performing a biliodigestive anastomosis or finally by spontaneous regression as in primary choledochitis or pancreatitis.—*T. Leucutia.*

Mirizzi, P. L. Diagnostic des obstructions incomplètes non calculeuses du cholédoque; leur traitement par la cystico-duodénostomie. (Diagnosis of incomplete non-calculous obstructions of the choledochus; their treatment by cystico-duodenostomy.) *Presse méd.* Jan. 25, 1936, *44*, 150–154.

The fact that the majority of biliary lesions is localized to the gallbladder proper well explains the successful result obtained in most of these cases by cholecystectomy. There are, however, certain instances in which operation remains unsuccessful because of the functional or anatomic disorders of permeability of the gall ducts. Among these, one may distinguish two main groups: (1) those cases in which the obstruction is of cicatricial or calculous nature and (2) those in which the obstruction is noncalculous and as a rule incomplete due to functional disorder of the choledochus, the gallbladder proper still remaining useful.

The author advocates that in these cases cholangiography be performed during the actual operation by injecting lipiodol into the gallbladder to exactly determine the nature of the obstruction. It is common experience that such instances, when only simple cholecystectomy is performed, sooner or later result in biliary fistulae, necessitating a second or even third operation later. The custom in most places is to inject the biliary fistula, postoperatively but by making use of the author's procedure one may detect the cause of the eventual unsuccess immediately at the first operation and thus outline the surgical technique so as to forestall complications later.

(1) In the first group, that is, when there is an anatomic obstruction, as, for example, a very small stone in the Heister valve or a very concentrated bile in the cystic duct, the lipiodol which is injected into the gallbladder will fail to pass into the choledochus. In such an instance it is easy to remove the obstacle without much injury to the biliary passages. The author has one particular case in mind in which a gallbladder operation was performed elsewhere resulting in biliary fistula; three attempts at lipiodol injection to determine the nature of the obstruction remained fruitless. Finally by performing a fourth injection at the time of the operation it was possible to find a complete occlusion of pancreatic origin which was then successfully relieved by external choledocho-duodenostomy.

(2) In the second group, when the biliary passage to the duodenum is blocked by functional or non-calculous obstruction of the choledochus, the author proceeds as follows: During the course of cholecystectomy he systematically conserves the neck of the gallbladder and the cystic duct. After ascertainingly by cholangiography the nature of the obstruction, he prepares an infundibuloform duct which he sews directly to the duodenum, thus establishing an infundibulo-cystico-duodenostomy. It is the author's contention that because of the very thin walls of the hepatic and choledochus ducts in such instances, it would be dangerous to perform an external choledocho-duodenostomy, whereas the infundibulo-cystico-duodenostomy, by establishing a second path of drainage of bile into the duodenum, invariably leads to success.

Five cases in which this method was employed are described in detail and illustrated with numerous roentgenograms and drawings. —*T. Leucutia.*

SKELETAL SYSTEM

Moreau, Laurent. Radiographie de l'apophyse styloïde. (Roentgenography of the styloid apophysis.) *Bull. et mém. Soc. de radiol. méd. de France*, 1936, *24*, 110–112.

The styloid apophysis seems to have only little importance from a pathologic standpoint. From the purely anatomic standpoint, however, roentgenographic examination furnishes very valuable data. As is known, the styloid apophysis projects downward and forward over the vaginal portion of the tympanic part of the temporal bone. It gives rise to the stylohyoid and stylomandibular ligaments and to the styloglossus, stylopharyngeus and stylohyoid muscles. For the roentgen examination the position of choice is the profile, the technique being similar to that used for the examination of the mandible. In the posteroanterior position with the nose on the cassette the apophysis is often visualized lying in the space between the superior maxilla and the internal aspect of the coronoid process.

The roentgen examination furnishes informa-

tion concerning the length, form and direction of the styloid apophysis. Factures rarely occur and chiefly in connection with extensive fractures of the condyloid process of the mandible. The styloid apophysis is well protected against direct fractures (by the mandible and mastoid process) and as to indirect fractures the muscles which are attached to it are too weak to exercise sufficient traumatic force. The anomalies of development no doubt form the most interesting group. Thus the hyoid apparatus may persist in whole or part. Certain authors have obtained roentgenograms proving this on detached pieces, others in the living. It must be mentioned, however, that the hyoid apparatus may easily be confused with the calcification of the stylohyoid ligament, especially at advanced age.—*T. Leucutia.*

Belot, J., and Simchowitz, H. Exostoses ostéogéniques multiples avec dégénérescence maligne chondro-sarcomateuse. (Multiple osteogenic exostoses with malignant chondrosarcomatous degeneration.) *J. de radiol. et d'électrol.*, Jan., 1936, *20*, 12–17.

Multiple osteogenic exostoses, although not very frequent, do not constitute an unusual diagnostic problem for the roentgenologist. It is generally admitted that the condition is benign and that malignant degeneration occurs only exceptionally. The authors observed such a malignant degeneration in a man, aged twenty-eight, who had developed a chondrosarcoma in one of the exostoses of the humerus. This case is described in detail and illustrated with roentgenograms and several photographs. —*T. Leucutia.*

Roehm, Harold R. Juvenile osteomalacia. *Am. J. Dis. Child.*, March, 1936, *31*, 615–632.

Roehm reports a case of generalized decalcification and atrophy of all bones in an eleven year old girl, with laboratory reports and autopsy findings. The picture presented was remarkably similar to that of the osteoporotic type of hyperparathryoidism without cystic degeneration reported by Albright and his associates, but in the absence of demonstrable parathyroid disease at operation by a particularly qualified surgeon and at autopsy by a qualified pathologist, this diagnosis could not be made. The osseous changes roentgenographically and histologically were not characteristic of juvenile or late rickets, and specific antirachitic therapy produced no improvement. The administration of amino-acetic acid by mouth produced a definite gain in weight, principally due to increased deposits of fat in the abdominal panniculus, but had no demonstrable effect on the creatine and creatinine in the urine or the muscular hypotonia.

Roehm quotes Locke's classification of the various forms of osteomalacia as follows: (1) the puerperal form, occurring especially in women who have had numerous and frequent pregnancies; (2) the non-puerperal form, the justification for this separation is questionable; (3) hunger osteomalacia; (4) senile osteomalacia; (5) juvenile osteomalacia. This form is uncommon in this country. Owing principally to the influence of Hess, it has been confused with juvenile rickets in recent years. Roehm states there are 5 reported cases in the available literature. He believes that two distinctly different conditions exist, the one an osteomalacic process of late rickets, the other a definite separate entity, an osteomalacia.

In the differential diagnosis the following diseases are to be considered: (1) juvenile rickets; (2) Paget's disease, osteitis deformans; (3) pituitary basophilism, Cushing's disease; (4) osteogenesis imperfecta, fragilitis ossium, osteopsathyrosis; (5) syphilitic osteitis; (6) congenital syphilis; (7) anterior poliomyelitis; (8) renal rickets; (9) celiac rickets; (10) hyperparathyroidism, osteitis fibrosa cystica multiplisata, Recklinghausen's disease; (11) multiple myeloma.

Patients with juvenile osteomalacia apparently are not improved by treatment. There appears to be no specific remedy. The antirachitic vitamin D alone or in association with vitamin A has no effect.

In Roehm's patient the serum calcium and phosphorus in sixteen different determinations were normal or, as on a few occasions in the case of calcium, somewhat high. On the first metabolic studies, there was a negative balance for both calcium and phosphorus but later determinations showed a change to positive. The roentgenographic studies showed a gradual but progressive absorption of lime salts in all the bones. In the later roentgenograms, the bony structure appeared to be of almost paper thinness and soft tissue technique was necessary to obtain bone detail. The bodies of the vertebrae were decalcified and markedly biconcave in appearance.

The etiology of the condition was not discovered but the case was considered by Roehm as a true juvenile osteomalacia.—*R. S. Bromer.*

BAASTRUP, CHR. I. Le "lumbago" et les affections radiologiques des apophyses épineuses des vertèbres lombaires, de la 1re vertèbre sacrée et des parties interépineuses. (Lumbago and roentgen affections of the spinous apophyses of the lumbar vertebrae, of the first sacral vertebra and of the interspinal parts.) *J. de radiol. et d'électrol.*, Feb., 1936, *20*, 78–93.

The author considers in lengthy detail, using numerous roentgenograms for illustration, the effect of changes of the spinal processes of the lumbar vertebrae and the upper segment of the sacrum on low backache. He arrives at the following general conclusions:

(1) Lumbago is considered either as a secondary muscular affection due to infectious maladies, lesions of the uterus and urinary organs, lesions of the vertebral bodies, etc., or as a primary muscular affection due to trauma or rheumatism. There is sufficient cause to believe that lumbago even in this latter form may be secondary, having the point of origin in the arches, articular facets and especially spinous processes of the vertebrae.

(2) The vertebrae constitute among themselves a lever system, in the lumbar region the spinous processes forming the small arm. For this reason the spinous processes under certain conditions might exercise a very great pressure on the interspinal tissues. Moreover a sudden pressure may result in hematoma which may be the cause of the lumbago. When the pressure is more or less continuous the interspinal parts may undergo destruction, leading to osteoarthrotic deformities.

(3) The causes of pressure of the spinal processes are (*a*) increased lordosis, as for example in tuberculous spondylitis, spondylolisthesis, scoliosis, congenital luxation of the hip, fractures, asthenia, adiposity; (*b*) increase of mass of the spinous process, as for example, in Paget's disease or fluorosis; (*c*) senile atrophy of the vertebral bodies and intervertebral discs, producing a diminishing of the space between the spinous processes; (*d*) deforming spondylosis; (*e*) congenitally high spinous processes or low vertebral bodies with a tendency to exaggerated lordotic posture, a fact which explains the so-called predisposition to lumbago. In this group belong the greatest part of the so-called traumatic and rheumatic lumbagos, even in the instances in which a deformity of the spinous processes cannot be demonstrated roentgenologically, since as a rule it takes a long time before such changes are advanced enough to be distinguishable by roentgenograms.

A final conclusion is drawn that in all cases of backache roentgenography of the lumbar spine and sacrum is indispensable and that special attention must be paid to the spinous processes.—*T. Leucutia.*

BENASSI, ENRICO. Una lesione traumatica spesso disconosciuta: l'infrazione della spina tibiale. (A traumatic lesion often not recognized: fracture of the spine of the tibia.) *Radiol. med.*, Feb., 1936, *23*, 110–115.

The more serious forms of fracture of the intercondyloid eminence of the tibia cause marked clinical symptoms, particularly copious hemorrhage into the joint which is readily recognized on roentgen examination. But in many cases of fracture of the spine of the tibia, perhaps the majority, the clinical signs are not so marked and if there is no displacement of the fragments it may be hard to demonstrate the fracture even roentgenologically. Frequently these fractures heal with no special therapeutic measures except the relative rest to which the patient is forced by the pain in the joint. So that later it may be impossible to recognize even quite a serious fracture of the spine of the tibia. This may be of importance in medicolegal cases. It may be impossible to recognize slight fractures even when they are fresh; the projection may be such that the line of fracture is not visible. There are also arthritic lesions that may simulate fractures of the spine. In difficult cases special oblique projections should be used and a roentgenogram of the knee in semiflexion made on a curved film in order to show the spine of the tibia with special clearness. The roentgenograms must be perfect in projection and detail and read with the greatest care in order to detect these fractures. Roentgenograms are given illustrating the difficulties of diagnosis in these cases.—*Audrey G. Morgan.*

BLOOD AND LYMPH SYSTEM

NAULLEAU, J., and CONTIADES, X.-J. Renseignements fournis par l'artériographie dans les anévrysmes artériels spontanés des mem-

bres. (Information furnished by arteriography in spontaneous arterial aneurysms of the extremities.) *Presse méd.*, Feb. 12, 1936, *44*, 250–253.

Arteriography occupies a most interesting position among the methods of examination in arterial aneurysms of the extremities. The authors, in a review of the literature, found about 40 cases and by adding their own personal case, which is here described in detail, they established the following anatomic, clinical and therapeutic criteria of the method: (1) *Anatomic Criteria:* (*a*) A multiplicity of aneurysms developing on the same vessel is usually considered as a rare occurrence but arteriography revealed that the opposite is true; (*b*) arteriography permits an exact localization of the lesion; (*c*) the degree of permeability of the sac determines the arteriographic aspect of the aneurysm. In this respect there are three possibilities: the cavity may become impregnated with the contrast medium and may appear morphologically fusiform, sacciform or multilobulated, or the sac may become partially obliterated and the arteriogram may show only slight fogging over the area of the aneurysm, or finally, the sac may appear completely obliterated, there being no roentgen visualization at all; (*d*) arteriography permits the estimation of the condition of the principal artery and its relation to the collateral branches; (*e*) finally, it permits the estimation to a certain extent of the state of blood vessels distant from the site of the aneurysm.

(2) *Clinical Criteria*: (*a*) Until now it has been practically a classical doctrine that aneurysm is the result of syphilis; yet, arteriograms in many instances reveal the presence of atheroma; (*b*) furthermore arteriography creates a doubt concerning the value of some of the clinical signs which hitherto have been considered indispensable to a diagnosis of an aneurysm, this referring especially to the value of pulsation, expansion, and the presence of a systolic murmur in the area of the aneurysm. It is now apparent that these signs may also occur in nearly complete obliteration of the aneurysms, a fact which made Dos Santos advance the theory that they may be due to transmission of a systolic wave through a noncontractile sac rather than actual activity of the aneurysmal wall. (*c*) The value of arteriography in the diagnosis of aneurysms is decidedly greater than that of pure clinical investigations for three reasons: first, it permits the detection of a latent aneurysm, secondly, it may indicate the presence of a circulatory disorder of the arteritic type when an aneurysm is suspected, and third, it gives definite information concerning data for surgical intervention, such as localization, presence of adhesions, etc.

(3) *Therapeutic Deductions:* There are instances in which preliminary arteriography may change the criteria of surgical intervention: (*a*) as it concerns the time of intervention. This may occur in at least two circumstances, first, when the aneurysm appears permeable but the collateral circulation is poor, in which case one may resort to the method of incomplete ligation as indicated by Halsted and Matas and reserve the more radical surgical intervention for later; and secondly, when there is evidence of a peri-aneurysmal infection, in which case, too, surgical intervention is performed later, after the clearing up of the infection. (*b*) By indicating the anatomic details around an aneurysmal sac arteriography permits the selection of the operative procedure leading to the best ultimate results.

All in all, it appears that arteriography in the preoperative examination of aneurysms is of the utmost importance. Despite the fact that some unfavorable accidents have been reported, it is the authors' opinion that by utilizing a well selected contrast medium and by studying closely the vasomotor reactions of the patient, one may forestall all complications, thus making the method a routine one in all those instances in which clinical examination is insufficient to insure the diagnosis and the clear operative indications.—*T. Leucutia.*

Cottenot, P., and Heim de Balsac, R. Étude expérimentale de la sémiologie radiologique de l'appareil circulatoire au moyen de la cardio-vasographie post mortem. (Experimental study of roentgen symptomatology of the circulatory system by means of post-mortem cardiovasography.) *Acta radiol.*, 1936, *17*, 256–274.

The authors injected contrast material into the heart chambers and the great vessels of cadavers in order to determine what anatomical regions correspond to all the various parts and contours of the cardiovascular roentgenogram with different angles of incidence of the rays. The cadavers were examined in an upright

position after insufflation of the lungs and without opening the chest wall. The injections produced isolated, simultaneous or successive fillings of the various heart chambers and the great vessels. The roentgenograms obtained were compared with those of the same individual before death.

The authors have in a previous publication reported all the results of their investigations and in this article only cite a certain number of examples. They have obtained very exact results as to the position and roentgen appearance of the heart chambers and great vessels with different incidences of the rays. They think this method will prove of great value in studying cardiovascular symptomatology.—*Audrey G. Morgan.*

GENERAL

TOURAINE, A. L'anidrose avec hypotrichose et anodontie. (Anhidrosis with hypotrichosis and anodontia.) *Presse méd.*, Jan. 25, 1936, *44*, 145–149.

Among congenital ectodermal defects, the so-called "anhidrosis with hypotrichosis and anodontia" (Siemens) occupies a special clinical position, little known in France. The syndrome which is familial and seems to obey the mendelian law of heredity is characterized by absence of the sweat and sebaceous glands, generalized hypotrichosis, and a total or nearly total lack of teeth. To this basic triad numerous other dysplasias may be added which refer chiefly to the embryonal ectoderm. Among them, the most frequent are atrophic rhinitis, with saddle nose, prominence of the superciliary arches and of the chin, thickening of the lips, malformation of the nails and finally, mental disorders. The ensemble thus represents the highest degree which may be reached by ectodermic dysplasias without, however, ceasing to be compatible with life.

The author, after a historical review, deals in detail with the symptoms, anatomic lesions, and pathogenic theories of the disease, using numerous rather unusual photographs collected from the literature for illustration.

From the point of view of the roentgenologist the interesting feature is in connection with the anodontia and the deformities of the skull. The anodontia may be total, no teeth being visible, in which case roentgenography of the alveolar processes may sometimes reveal a few dental roots enclosed in one of the jaw bones. In other cases, there are a few teeth present, usually the two upper incisors and two premolars. If the number exceeds four, one may also encounter some teeth in the lower jaw but always in a lesser number than in the upper. The teeth appear deformed, atrophic, pointed or conical, deserving the denomination of "pig teeth." The changes observed in connection with the face and skull are the saddle nose, the very prominent superciliary arches of the frontal bone and the protrusion of the chin.

It is interesting that the longevity in the cases afflicted with such a condition appears normal, many of the cases described in the literature being between the ages of forty-eight and fifty-eight.

Concerning the etiology, the opinion is expressed that syphilis may play a rôle although not in the form of a direct hereditary lues of the first generation but as a later form of the second or third generation, the transformation occurring according to the heredity law of Mendel.—*T. Leucutia.*

ROTHSTEIN, JACOB, and WELT, SARA. Calcinosis universalis and calcinosis circumscripta in childhood. *Am. J. Dis. Child.*, August, 1936, *52*, 368–422.

Rothstein and Welt report 3 cases of calcinosis universalis together with a very extensive review of the literature. The paper is profusely illustrated with roentgenograms of their patients. Their conclusions and summary follow:

Calcinosis, or the abnormal deposition of calcium salts in the body, may occur alone or in association with other conditions. Scleroderma, dermatomyositis and myositis ossificans frequently precede or occur in conjunction with the calcinosis.

Calcinosis, they believe, represents another stage in the development of the underlying pathologic process, which may have first manifested itself as a scleroderma, dermatomyositis, myositis fibrosa or myositis ossificans. Certainly the latter conditions and calcinosis are closely related.

The pathogenesis of calcinosis is obscure. What factor determines why and when the calcification shall occur and in what sites cannot be stated. It can only be suggested that the calcification is preceded by, and its sites of predilection are determined by, a local change in the tissue, possibly the result of one or more

of the following factors: a local injury to the tissue secondary to trauma or infection, an interference in the local vascular supply or a disturbance in the local metabolism or the local acid-base equilibrium.

The customary division of calcinosis into two types (calcinosis circumscripta and calcinosis universalis) seems to be an artifical and unnecessary separation of what may be merely two different stages in the extent of development of the process of calcification. Reference has been made to borderline forms, difficult of classification, which might be grouped differently by different observers. To avoid confusion, it has been suggested that until more is known of the etiology and pathogenesis of this aberrant calcification all forms might be grouped under the general name of calcinosis rather than be subdivided according to location, or to the tissues involved, as has been done hitherto.

The review of the literature covers 36 cases of calcinosis, both universalis and circumscripta in type, all occurring in infants and children up to fifteen years of age. Cases of metastatic calcification in children were not included.—*R. S. Bromer.*

Abt, Arthur F., and Denenholz, Edward J. Letterer-Siwe's disease: Splenohepatomegaly associated with widespread hyperplasia of nonlipoid-storing macrophages; discussion of the so-called reticulo-endothelioses. *Am. J. Dis. Child.*, March, 1936, *51*, 499–522.

The authors report a case which they believe falls within the group of cases first described by Letterer (1924) and later by Siwe (1933). According to Siwe's criteria, the condition is characterized by the following distinctive features:

1. There is marked splenomegaly, with from moderate to considerable enlargement of the liver.

2. A hemorrhagic tendency, chiefly manifested as petechiae or purpura, has been consistently noted.

3. There is a generalized enlargement of the lymph glands. The glands are discrete and not tender.

4. Localized tumors over the bones may be present but the osseous involvement may be recognized only by the aid of the roentgenogram or at autopsy.

5. The blood picture is characterized by secondary anemia of a progressive, nonregenerative type. The leukocyte count is normal or somewhat diminished. The differential count is within normal limits and in none of the cases was there a marked increase in the percentage of mononuclears. The number of platelets, in those instances in which they were reported, was not consistently diminished.

6. Splenic puncture may reveal an increased number of nonlipoid-containing macrophages.

7. The disease is neither of a hereditary nor of a familial character and it occurs exclusively in infants. The onset is acute and unrelated to infection. The course is gradually downhill, and the duration of the disease has varied from a few weeks to several years. The etiology is unknown.

8. The pathologic changes are characterized by a generalized hyperplasia of the macrophages in various organs. The cells are nonlipoid-storing and characteristically are large, round or polygonal mononuclear cells. The cytoplasm is pale-staining.

In 1 of the 9 reported cases in the literature of this condition, cystic areas were found by roentgen examination in the right humerus and in a second case in the left fibula. In the case here reported, there was a large defect in the skull.

The authors state that in the recent literature, a wide variety of clinically and anatomically different diseases have been associated as subgroups under the general classification of reticulo-endotheliosis. These include infectious diseases of various origin, tuberculosis, malaria, typhoid, etc.; certain leukemias, in particular that termed monocytic leukemia; neoplastic diseases, such as reticulum cell sarcoma and endothelioma; lymphogranulomas, such as Hodgkin's disease, and Letterer-Siwe's disease. Some of these are of known and others of unknown etiology. They attempt to point out that there is no advantage, either for clinical diagnosis or for pathologic classification, in grouping these heterogeneous conditions under the term reticulo-endotheliosis.—*R. S. Bromer.*

ROENTGEN AND RADIUM THERAPY

Galifi, Liborio. La Röntgen- e la Radiumterapie del cancro cutaneo. (The roentgen and radium treatment of skin cancers.) *Radiol. med.*, Feb., 1936, *23*, 65–89.

Twenty-seven cases of skin cancer treated by irradiation are described and illustrated with photographs.

It is a generally accepted opinion that basal cell cancers are more amenable to radiation treatment than prickle cell cancers. The author has not found this true in his material, however. He thinks that with equal size of the tumor equally good results can be obtained with modern technique in the different histological forms of tumor. He thinks it is possible to judge from clinical examination alone of the possible results of irradiation, regardless of the histological character of the tumor.

He concludes from his experience that irradiation is the treatment of choice in skin cancers. Among his cases he had 93 per cent cure in cases that had not been treated previously and 25 per cent cure in those that had been treated previously. Among the 23 cases which had not been treated previously there was death in only two. One of these was a very large cancer covering almost all the left half of the face and the other was at the inner angle of the right eye. The tumor disappeared in the second of these cases and was greatly improved in the first but the patients died of metastases. In the other 21 cases there was complete cure with soft, non-adherent scars.

In the cases treated with roentgen irradiation he used soft rays, with a minimum filtration, with the following technique: 95 kv., 2 ma., filter 1 mm. aluminum, focus-skin distance 24 cm., with a dosage of 1,600 r given all at once. He used a single portal of entry, covering the tumor and a small ring of normal tissue around it; leaded rubber was used to protect the surrounding skin. When radium was used it was given by means of needles or apparatus modeled to the lesion, depending on the conditions in each case.

The prognosis depends to a great extent on the size of the tumor and whether there are recurrences. The chances of success are much less with very large tumors and recurrence presupposes a certain degree of malignancy.

An effort should be made to give a sufficient dosage at one treatment to destroy the tumor. If some of the tumor persists after the first treatment, it is advisable to change the kind of irradiation, that is if roentgen rays have been used for the first treatment to use radium for the second, and vice versa, in order to get the benefit of the different biological action of these two kinds of irradiation. With reference to the question of acquired radioresistance when the tumor is insufficiently treated, he thinks radioresistance may be kept up by latent secondary infection. He is inclined to prefer radium to roentgen treatment as a general rule in skin cancers, though no definite rule can be given that is applicable to all cases. The success of treatment depends on the proper choice of method for the special case in question and sometimes on the adoption of special technical details.—*Audrey G. Morgan.*

TORRIGIANI and PALUMBO. Radiumterapia dei tumori maligni delle prime vie respiratorie. (Radium therapy of malignant tumors of the upper air passages.) *Ztschr. f. Hals-, Nasen- u. Ohrenheilk.*, 1936, *40* (*Kongressbericht*), 44–133.

Authors' Summary. Our report is a short synthesis of personal observations during a period of 25 years' collaboration. As we said above, only a little part of our work is reported in these tables, which state the cases of the latest period, and are particularly interesting as they give evidence of the present condition of Curie-therapy. The result obtained in earlier periods during all the evolution of this therapeutical method, if added to our latest results, would alter statistic data, as they have been obtained with methods which are already obsolete. Their meaning would be merely historical and unfortunately not without unfavourable statements; such, however, has always been the case during the transitional phase of every therapy, which has to overcome the unavo d-able drawbacks of the experimental period, before reaching complete efficiency.

According to our present knowledge, we can assert that the keystone of the whole radiotherapeutic system is represented by *dosing.*

The physics and pathological anatomy have contributed some basic elements towards the averment of radiotherapy; the first of these sciences by studying the whole series of rays according to their wave-length, frequence and nature; the second one by studying their influence on the different blastomatous manifestations. Radio-biology has lately brought much light in this problem by trying to discover the innermost mechanism by which rays influence living matter, and the ensuing reactions; it promises to contribute still more to the explanation of these theoretical problems from which only depends every practical fulfilment.

The synthesis of every research must be

rated clinically, because only clinically it is possible to harmonize general data with the needs of every particular case, deducing from it the therapeutical formula. The necessity of collaboration between clinicians of the different branches and the radiotherapist emerges clearly from the aforesaid statements. Everybody knows that the most important work in this field has been accomplished by the united efforts of a clinician and a radiotherapist. This collaboration should go from the diagnosis to the settling of the therapeutical program, to the control during the treatment and the period of reaction, to the methodical watching after the treatment. This statement is particularly true in our rhino-laryngological field, where the exactness of the anatomo-pathological findings is essential for the further therapeutical decisions; this exactness can be exclusively obtained by the specialist being absolutely master of the finest methods of investigation in this complicated field.

We think that the most important rule in the fight against malignant tumours is the following: *we must employ larger surgical proceedings and radiotherapy of greater intensity than the clinical data would lead us to consider sufficient. If this statement is right*—as we are sure—*for surgery, it appears still more necessary with regard to radiotherapy, which, according to our belief, must always reach its maximum.*

The general conditions of patients must be the basis for the practical fulfilment of radiation therapy.

The method of the protracted-fractioned dose gives us the possibility of fulfilling this condition; the reacting powers of the organism are kept in efficiency: consequently the ray-dose can be raised to its highest degree.

The fundamental problems of surgery as well as of radiotherapy, are three: *1. Tumours, 2. Lymphnodes, 3. Recurrences.*

Each one of these problems and, a fortiori, all three together, strengthens our opinion, that every therapeutical treatment must be of high intensity. In the treatment of the tumour, surgery is represented by a direct operation, as large as possible, but always in connection with the site and extension of the tumour.

Radiotherapy is on the contrary extended to the whole region and the melting of the tumoral tissue is obtained not only by the direct influence of rays, but also by their indirect influence through the modifications in the irradiated tissues.

The best prophylactic means against recurrences is represented by the most intense and uniform irradiation of the whole region of the neck. Everybody knows that a second treatment by irradiation can only give a poor result; therefore the necessity of applying the greatest effort during the first treatment. The radiation must not be less intense in the treatment of lymphnodes, which are very radioresistant and can disappear only after a treatment of such intensity.

Our work has been divided into three parts and each of them corresponds to different anatomical and clinical conceptions, as well as to different therapeutical rules.

In treating the tumours of the nasal cavity and paranasal sinuses we have come to the conclusion that these regions belong to radiosurgery.

In epithelial forms these two therapeutical actions complete each other at the same moment or in two different phases. Radiotherapy alone can be sufficient only in some very radiosensitive tumours, especially those of sarcomatous nature.

When the site of the tumour is in the paranasal sinuses, we employ the operation which has been proposed by one of us (*Torrigiani*): *we make a permanent opening in the sound bony palate*, which gives to the physician and the patient himself, the possibility of detecting any eventual recurrence at its earlier stage and fighting it by the finest technical means. By this method it is easier to observe the region during the period of reaction and apply the corresponding symptomatical local therapy.

In this way, we have obtained some really remarkable results in cases where a second operation would otherwise have been made too late or would have been impossible.

A similar method should be adopted with tumours of the ethmoidal region, when the orbit is invaded, or the surgical extirpation is not surely complete, and the patient can be persuaded to sacrifice one eye, even if its function is still normal.

A permanent opening in the orbital cavity can bring about the same advantages of control and treatment of an eventual recurrence, as the palate opening does when the localisation is in the antrum.

Eventual objections to the perforation of a sound palate and the emptying of the orbit when the eye is still normal, could be easily answered by saying that the preservation of

life is well worth a sacrifice, however painful and maiming such as that of one eye.

As regards the palate, a common prothesis will prevent any trouble; unlike ocular enucleation, it is accepted by patients, who readily recognize the opportunity of such an operation.

The best proof of the practical utility of this method is given by the results we obtained in this field, in which the problem of recurrences is still more important than the lymphnode one.

The pharyngeal cavity is one of the regions in which surgery has made and still makes very noble efforts, with serious and complicated operations, which do not always meet with the success they deserve.

On this account radiotherapy is strongly indicated in this field, especially for larger tumours.

In the hypopharynx the effects of radiation are very limited, although we often obtain melting of the tumour with clinical cure. The persistence of lymphnodes and tumoral recurrence represent two dangers against which our means are not sufficient, notwithstanding the most intensive, fractioned and protracted doses.

In the epipharynx our results have been comparatively more satisfactory. It is certain that the problem of lymphnodes, which sometimes is remarkable, is often less serious than in the hypopharynx. After the melting of the tumour the further course is less unfavourable. Survivals have been longer than in hypopharyngeal tumours.

If differences between the results obtained in those two regions, however remarkable, are not too great, they are much more important if we compare those results to the ones obtained *in the mesopharynx*. In the whole pharynx this is the site that offers the greatest therapeutical possibilities.

Surgery gives in this region better results, not only in small, but even in large tumours.

The results of radiotherapy are however not less favourable: its importance is evident if one considers (as our statistics show) the possibility of permanent cures, not only of sarcomatous, but even of epithelial forms.

The tele-curie-therapy, which represents our favorite therapy is, whenever possible, combined with the direct endotumoral irradiation; this treatment is usually done in tumours of the mesopharynx, exceptionally in those of the epipharynx, and it is impossible in tumours of the hypopharynx.

The tumors of the larynx are generally classified as *intrinsic* and *extrinsic*. In our paper we have considered as laryngeal only the intrinsic ones, having classified as hypopharyngeal the tumours of the external ridge of the glottis, otherwise known as pharyngo-laryngeal.

The intrinsic tumours (laryngeal, according to our classification) have been divided by us into: *tumours of the cord, tumours situated above and tumours situated beneath the cord*. This classification obviously applies to earlier stages and is useful for therapeutical indications. We think that *in tumours of the cord, in which movements of the cord are still present, surgery can be avoided*. This statement is in contrast with the more common conviction that one should resort without any hesitation to the extirpation of the tumour by means of a laryngo-fissure, or by natural ways (according to the advice of some competent colleagues).

In order to avoid opening of the air passages from outside and an account of the unreliability of the endo-laryngeal operation, several radio-surgical methods have been applied without opening the air passages.

We have come to the conclusion that *the same therapeutical results can be obtained by irradiating through the skin*, without having to fear radionecroses, which could not be prevented, even by surgery of laryngeal cartilages.

The objection that by this method one does not obtain the guarantee of surgical extirpation can be answered by saying that, whenever irradiation fails, one has always the possibility of making a laryngo-fissure, which normally we have avoided.

This rule is supported by the latest acquisitions of radio-biology regarding the cytolytic action of irradiation on neoplastic elements and the sclerosis produced in the submucous tissues.

This effect of rays on the site of the tumour lessens the probability of a recurrence, so much that it is advisable even after surgical extirpation.

In several cases of tumour of the cord, in which the movements were limited and in which surgery, that we always advocated, had been rejected, we obtained cures by mere irradiation through the skin.

In tumours situated above or beneath the cord, in which a prompt extirpation is neces-

sary, we always insist, if the injury extends only to one half of the larynx, in advising the hemilaryngectomy according to *Glück;* this method is in accordance with our therapeutical system, followed in the paranasal tumours, as it affords the possibility of control during a long period and of detecting an eventual recurrence at its earlier stage. If the laryngeal tumour, situated above or beneath the cord, invades both halves, the radical therapeutical method is given by laryngectomy.

Every case treated by a simple or enlarged laryngo-fissure, with partial or even total extirpation of the organ, will benefit by a postoperative irradiation on account of the sterilizing action of rays on the ground in general and on the lymphatic sites in particular.

These rules and the results to which they have led, are the result of the harmonic blending of the only two therapeutical methods we presently dispose of in the struggle against malignant tumours of the superior air passages as well as of all other sites.

It will be a philanthropical work to convince physicians and patients that cancer of several regions can be cured if promptly diagnosed and properly treated; the tumours of the superior air and food passages are not amongst the most unfavourable.

Justin-Besançon, L. L'exophthalmie basedowienne; recherches cliniques et pathogéniques. (Basedow's exophthalmos; clinical and pathogenic researches.) *Presse méd.*, Jan. 18, 1936, *44*, 105–110.

The author in this article gives a very detailed discussion of the clinical aspect, experimental results, humoro-vegetative pathogenesis and therapy of the exophthalmos in Basedow's disease. Concerning the therapy he makes the following statements directly of interest to radiologists: The treatment of exophthalmos in Basedow's disease must first suppress the hyperthryoidism and secondly the excitation of the endings of the orbital sympathetic nerves. The most efficient method to obtain the first is surgical removal of the thyroid gland which results in a disappearance of the exophthalmos in more than 60 per cent of the cases. The effect of radiation therapy is less pronounced, although it is admitted that in a considerable number of cases exophthalmos is reduced or made to disappear. The administration of iodine medically is of great aid in enhancing the results. In a certain number of cases, in spite of all treatments of the thyroid gland, the exophthalmos will continue to persist. In these instances one must resort to the second form of treatment, that is, the use of sympatheticolytics which aim to suppress the excitation of the orbital sympathetic nerves. The greatest benefit was derived from the alkaloids of the yohimbine group. It is very important, however, that one use only preparations subjected to biological control which are efficacious against exophthalmos provoked by ephedrine in cats and which are very little toxic. The dextrogyral isomers lead to symptoms of intolerance such as nausea, nervousness and insomnia, whereas the levogyral isomer (corynanthine) is well supported. With time the system develops a tolerance and therefore the dose must be gradually increased. The author prescribes capsules of 2 centigrams of the alkaloid in gradually increasing doses until a total of 5 capsules, that is, 10 centigrams, is reached. The medication is continued uninterrupted for four to six months; after that intervals of rest of fifteen days are allowed every two or three months. Concerning the results obtained, he states that in one group a complete disappearance of the exophthalmos was obtained within eight to ten months; in a second group there was definite amelioration and in a third, including only few cases, there was no result.—*T. Leucutia.*

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